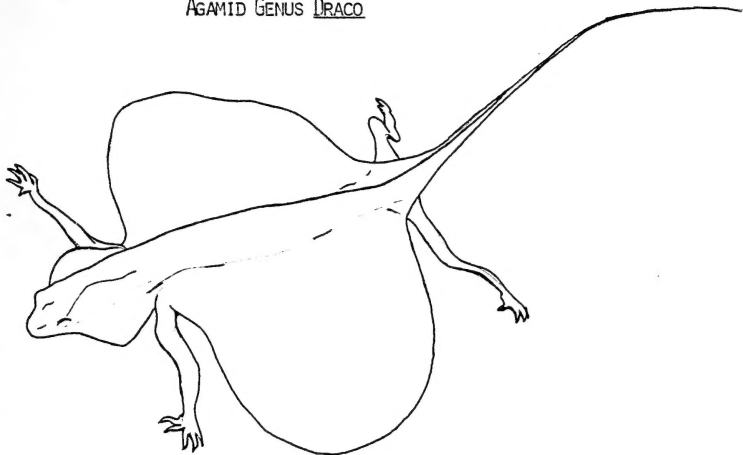


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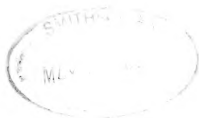
BIBLIOGRAPHY
OF THE
AGAMID GENUS DRACO



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INTRODUCTION

My interest in the lizards of the family Agamidae and particularly the genus Draco has evolved into an accumulation of numerous notes and references. Since I believe that I have seen and examined the greater bulk of the scientific literature on Draco it appears prudent, at this time, to organize and to assemble relevant parts of the amassed material into a workable and useful device for investigators of this lizard. The present effort, a partially annotated bibliography, is the result.

The bibliography is arranged by species/subspecies, as the case may be, and under each by a variety of subjects. Some of the subject headings require explanation and this is given below. The species/subspecies nomenclature follows the listing of Hennig (1963a) and Wermuth (1967). Hennig wrote a revision of the genus Draco in 1936 -- the last time that this was attempted. However, for many of the different species, good series were unavailable or non-existent at that time. Thus, a new look at the genus is needed and should be possible today because of the availability of larger series of these lizards in collections. One unfortunate note should be mentioned; the loss of some types as a result of bomb damage to the Dresden Museum during World War II (see Obst 1977).

Under each subject heading is listed an author's name followed by the date for reference to a more complete citation in the literature section at the end of the bibliography. A referenced citation may refer to a paper which contains an extensive discussion of the topic or merely a very brief statement. When an article was found to contain any pertinent information, it was included in the bibliography. In a referenced paper, when a taxonomic name is used (which is considered a synonym by Hennig (1936a) and/or Wermuth (1967)) and is not easily referable to the taxon under discussion, it (the name used in the referred work) is placed in parentheses after the author's name and the date; i.e., under: Draco volans reticulatus, Description: Taylor 1918 (rizali), rizali was the name used by Taylor in 1918 and is considered D. v. reticulatus in this bibliography. In other instances in the bibliography the parentheses after author's name and date is used to give the reader an inkling of what is in the paper cited.

Subject headings and explanations of the topics included under each are:

Synonymy: includes references containing partial or complete synonymies. Taxonomic names in parentheses are those used by the authors and not easily referable to the name used herein.

Distribution: includes references containing any geographical information on range, distribution (specific and general), and even collecting sites. Authors who quoted other earlier writers are also listed.

Description: includes references containing any information about diagnosis, anatomy, morphology, markings, pattern, color, physical appearance, physical measurements -- in toto, descriptive material.

Specimens identified: includes references to identification of specimens by field, collector's or museum numbers, deposition in collections with or without identification number, or any information about a specific animal or its occurrence.

Environment: includes references to habitat type or any environmental factor including altitude (alt. in parentheses following the author's name and year of publication of the article).

Eggs: includes references to number of eggs contained in a female or laid, nesting sites, incubation time, description of eggs or other mention of Draco eggs.

Behavior: includes references to general behavior, activity, breeding, courtship, feeding, aggression, or display.

Gliding: includes references to gliding and locomotion.

Food: includes references to foods eaten, identified by observation or by stomach content examination (it is accepted generally that Draco feeds almost exclusively on ants).

Sexual dimorphism: includes references to sexual dimorphism when specifically pointed out by an author.

Miscellaneous: includes references to topics or discussions that do not fit into the headings mentioned above or where some confusion exists as to the heading under which the material should be placed.

Comparisons: includes references to affinities, differentiation of species/subspecies, and comparison of species/subspecies.

Keys and Synopses: includes references to partial or complete keys, or, in some instances, tabular differentiation of a few species or subspecies.

Notice should be taken of errors in the literature. Some authors, unfortunately, did not bother to edit their writings or copied errors from other works. One of the most glaring is the Bartlett 1895 citation found in many references (in fact, I found no correct citation, including Hennig 1936a). The correct reference is given in the "Literature" section. Some papers I could not locate due to inaccuracies in the citation, others I did not examine, due to their rarity and my inability to quote pertinent page numbers to librarians for securing xerox copies -- they invariably refused to copy a complete book or monograph, and I could not visit the pertinent library. These papers are listed at the end of the "Literature" section.

Acknowledgements: I am grateful to Jack Marquardt of the Smithsonian Institution Library for his constant, expert and cheerful assistance in locating many items in the bibliography. I thank Ron Heyer, George Zug, Ron Crombie and the staff of the Division of Reptiles and Amphibians, Smithsonian Institution, for their help and many courtesies. I also thank Jeremy and Debbie Jacobs for obtaining copies of many of the references.

SPECIES INDEX

Draco affinis Bartlett

Synonymy: de Rooij 1915; Wermuth 1967.

Description: Bartlett 1895; de Rooij 1915.

Distribution: Bartlett 1895; Laurenti 1768 (major); Wermuth 1967; Werner 1910.

Specimens identified: Bartlett 1895.

Miscellaneous: de Rooij 1915 (not sufficiently described); Hennig 1936a (questions validity).

Comparisons: de Rooij 1915 (similarities with cornutus).

Draco blanfordii Boulenger

Synonymy: Boulenger 1885, 1912 (cyanolaemus); Hennig 1936a (cyanolaemus = blanfordii); Smith 1930 (cyanolaemus), 1935, 1937 (cyanolaemus); Taylor 1963; Taylor and Elbel 1958; Wermuth 1967.

Description: Biswas 1967; Blanford 1878; Boettger 1892; Boulenger 1885, 1890a, 1908, 1912; Hennig 1936a; Mason 1882; Smith 1916b, 1930, 1935, 1937; Taylor 1963; Taylor and Elbel 1958.

Distribution: Biswas 1967; Blanford 1878; Boettger 1892; Boulenger 1885; 1890a, 1903, 1908, 1912; Bourret 1939b, 1943; Cochran 1930; Hennig 1936a; Mason 1882; Robinson and Kloss 1915; Smith 1916a, b, 1930, 1935; Suvatti 1950; Taylor 1963; Taylor and Elbel 1958; Wermuth 1967; Werner 1910.

Specimens identified: Cochran 1930; Hennig 1936a; Taylor and Elbel 1958.

Environment: Boulenger 1908, 1912.

Eggs: Taylor 1963 (recants earlier error in writing that Draco eggs are laid in trees).

Miscellaneous: Blanford 1878 (major, "the nearest described species are D. quinquefasciatus of Penang and D. dussumieri of Malabar, ..."); Boulenger 1885 (figured), 1908 (bears some slight superficial resemblance to quinquefasciatus); Hennig 1936a (differentiates blanfordii from formosus and from dussumieri, see also discussion on cyanolaemus and blanfordii); Mason 1882 (nearest "akin" to dussumieri); Smith 1937 (allied to formosus and taeniopterus); Taylor 1963 (cyanolaemus "superficially" resembles the pattern of taeniopterus).

Draco dussumieri Dumeril and Bibron

Synonymy: Boulenger 1885, 1890a; Constable 1949; Fitzinger 1843 (also Draco duvaucelii); Gray 1845; (Dracocella); Hennig 1936a; Smith 1935; Wermuth 1967.

Description: Anderson 1871; Bhatnagar and Gaur 1967 (conducting system of the heart); Boettger 1892; Boulenger 1885, 1890a; Constable 1949; Dumeril and Bibron 1837; Faur 1971 (conducting system of the heart); Gunther 1864; Hennig 1936a; Jerdon 1854; John 1962 (newly hatched young), 1970 (biochemistry of muscle), 1971b (caudal musculature,

copulatory organ); McCann 1940; Prakash and Raghavaiah 1957 (heart), 1958 (heart); Prasad 1955 (skull); Satyamurti 1962; Schlegel 1837-1844; Smith 1935.

Distribution: Anderson 1871; Biswas 1967; Boettger 1892; Boulenger 1885, 1890a; Dumeril and Bibron 1837; Ferreira 1897; Gunther 1864; Hennig 1936a; Jayarum 1949; Jerdon 1854; John 1962, 1967a; McCann 1940; Satyamurti 1962; Smith 1935; Themido 1941; Wermuth 1967; Werner 1910.

Specimens identified: Boettger 1892; Constable 1949; Ferreira 1897; Hennig 1936a.

Environment: Boulenger 1890a; Gunther 1864 (after Jerdon 1854); Jerdon 1854; John 1967b; Satyamurti 1962; Smith 1935.

Behavior: John 1962; 1967b (display, courtship, feeding), 1967a, 1970 (territorial); McCann 1940.

Eggs: John 1962; McCann 1940; Satyamurti 1962.

Sexual dimorphism: McCann 1940.

Gliding: McCann 1940.

Food: Satyamurti 1962.

Draco fimbriatus fimbriatus Kuhl

Synonymy: Bartlett 1895 (grandis); Boulenger 1885 (cristatellus, fimbriatus), 1912; Cantor 1847; de Rooij 1915 (cristatellus); Dumeril and Bibron 1837; Fitzinger 1843; Grandison 1972; Gray 1845; Hennig 1936a; Mertens 1936; Smith 1930; Stoliczka 1873 (abbreviatus); Taylor 1963; Wermuth 1967.

Description: Bartlett 1895 (grandis); Boettger 1892; Boulenger 1885 (cristatellus, fimbriatus) 1903, 1908, 1912; Cochran 1930; de Rooij 1915 (cristatellus, fimbriatus); Dumeril and Bibron 1837; Grandison 1972; Gray 1831 (abbreviata); Gunther 1872 (cristatellus); Hardwicke and Gray 1827 (abbreviata); Hennig 1936a, b; Kuhl 1820, 1824; Kuhl and Hasselt 1822; Mertens 1929; Schlegel 1837-1844; Smedley 1931; Smith 1916b; Stoliczka 1873; Taylor 1934, 1963; Wiegmann 1831.

Environment: Boettger 1892 (1200 m alt.); Boulenger 1903 (alt.), 1908 (alt.), 1912; de Rooij 1915 (alt.); Grandison 1972; Hennig 1936a (alt.).

Eggs: Kopstein 1938; Ridley 1905; St. Girons 1956; Taylor 1963.

Food: Mertens 1929.

Sexual dimorphism: Mertens 1929.

Distribution: Bartlett 1895 (cristatellus, grandis); Boettger 1892; Boulenger 1885 (cristatellus, fimbriatus) 1903, 1908, 1912; Bourret 1943; Cochran 1930; Dammerman 1929; De Jong 1930; de Rooij 1915 (cristatellus, fimbriatus); de Witte 1933; Dumeril and Bibron 1837; Fitzinger 1826; Flower 1896, 1899; Grandison 1972; Gunther 1872, 1895; Hardwicke and Gray 1827 (abbreviata); Hennig 1936a, b; Kopstein 1938; Kuhl 1820, 1824; Kuhl and Hasselt 1822; Laidlaw 1901 (cristatellus, fimbriatus); Lampe and Lindholm 1901; Mertens 1929, 1930, 1934b; Macquard 1890; Ridley 1905; Schlegel 1837-1844; Smedley 1931; Smith 1916a, b, 1925, 1926, 1930; Stoliczka 1873; Suvatti 1950; Taylor 1934, 1963; van Lidth de Jeude 1905; Wermuth 1967; Werner 1910 (cristatellus, fimbriatus).

Gliding: Mertens 1958, 1960a.

Comparisons: Baumann 1913; Hennig 1936a, b; Van Lidth de Jeude 1905.

Behavior: Mertens 1929.

Specimens identified: Bartlett 1895 (cristatellus, fimbriatus, grandis);

Boettger 1893a; Boulenger 1885 (cristatellus, fimbriatus); Cochran

1930; Grandison 1972; Hennig 1936a; Smedley 1931; Taylor 1934, 1963.

Miscellaneous: Gray 1831 (abbreviata, common name: short-pouched dragon).

Draco fimbriatus mindanensis Stejneger

Synonymy: Hennig 1936a; Taylor 1922a, b; Wermuth 1967.

Description: Hennig 1936a, b; Stejneger 1908; Taylor 1922a, b.

Distribution: Brown and Alcala 1970; Hennig 1936a, b; Stejneger 1908;

Werner 1910; Wermuth 1967.

Sexual dimorphism: Taylor 1922a, b.

Specimens identified: Taylor 1922b; Stejneger 1908; Hennig 1936a.

Comparison: Stejneger 1908; Hennig 1936a, b.

Environment: Stejneger 1908; Taylor 1922a.

Draco formosus formosus Boulenger

Synonymy: Boulenger 1912; de Rooij 1915; Hennig 1936a; Grandison 1972; Smith 1930; Taylor 1963; Wermuth 1967.

Description: Boulenger 1900b, 1903, 1908, 1912; de Rooij 1915; Grandison 1972; Hennig 1936a, b; Laidlaw 1901; Smedley 1931; Smith 1916a, b, 1922, 1930; Taylor 1963; Werner 1910.

Distribution: Boulenger 1900b, 1903, 1908, 1912; Bourret 1943; de Rooij 1915; Grandison 1972; Hennig 1936a, b; Laidlaw 1901; Smedley 1931; Smith 1916a, b, 1922, 1925, 1926, 1930; Suvatti 1950; Swarder 1933; Taylor 1963; Wermuth 1967; Werner 1910.

Environment: Boulenger 1900b, 1908, 1912; de Rooij 1915; Grandison 1972; Smith 1916b, 1931; Taylor 1963; Wermuth 1967 (alt.).

Specimens identified: Grandison 1972; Hennig 1936a; Smedley 1931; Smith 1922.

Comparisons: Boulenger 1900b, 1912; Hennig 1936a, b; Smith 1937; Taylor 1963; Werner 1910.

Behavior: Boulenger 1903.

Eggs: Grandison 1972.

Miscellaneous: Mertens 1934a (Smedley's theory of size, melanism and island habitats).

Draco formosus laetipictus Hennig

Synonymy: Hennig 1936a (n. ssp.); Wermuth 1967.

Description: Hennig 1936a; Obst 1977.

Distribution: Hennig 1936a; Obst 1977; Wermuth 1967.

Specimens identified: Hennig 1936.

Miscellaneous: Obst 1977 (type destroyed during WWII bombing).

Draco formosus obscurus Boulenger

- Synonymy: Baumann 1913 (affinis not of Bartlett); de Rooij 1915; Hennig 1936a; Wermuth 1967.
- Description: Boulenger 1887b; Baumann 1913 (affinis Baumann); de Rooij 1915; Hennig 1936a, b.
- Distribution: Baumann 1913 (affinis Baumann); Boulenger 1887b; de Rooij 1915; Hennig 1936a, b; Mocquard 1890; Voris 1977; Wermuth 1967.
- Specimens identified: Baumann 1913; Hennig 1936a.
- Comparisons: Baumann 1913 (affinis Baumann and blanfordii); Hennig 1936a, b; Mocquard 1890 (with blanfordii).
- Eggs: Inger and Greenberg 1966.
- Environment: Boulenger 1887b (alt.); Voris 1977.
- Miscellaneous: Baumann 1913 (affinis Baumann, type probably in Bern Naturhistorische Museum).

Draco haematopogon haematopogon Gray

- Synonymy: Boulenger 1885; de Rooij 1915; Fitzinger 1843 (haematopogon Boie, reinwardtii); Gray 1831, 1841 (Dracocella); Hennig 1936a; Taylor 1963; Wermuth 1967.
- Description: Boettger 1892; Boulenger 1885; de Rooij 1915; Dumeril and Bibron 1837; Gray 1831; Hennig 1936a, b; Schlegel 1837-1844; Taylor 1936; Volz 1904.
- Distribution: Bartlett 1895; Boettger 1892, 1893a; Boulenger 1885, 1894b; Bourret 1943; Dummerman 1929; de Rooij 1915; Dumeril and Bibron 1837; Hanitsch 1898; Hennig 1936a, b; Mertens 1930, 1957b; Mocquard 1890; Taylor 1963; Van Lidth de Jeude 1905; Volz 1904; Wermuth 1967; Werner 1910.
- Environment: Boettger 1892 (alt.); de Rooij 1915 (alt.); Hennig 1936 (alt.); Taylor 1963.
- Comparisons: Hennig 1936a (microlepis), b; Taylor 1963 (microlepis).
- Specimens identified: Bartlett 1895; Boettger 1893a; Boulenger 1885; Hennig 1936a.
- Miscellaneous: Hennig 1936a; Wandolleck 1900 (ref. not seen, defined taeniopterus from Java -- but it must have been haematopogon); Mertens 1957 (error in Hennig 1936, i.e., Gray page 34, 1831 should read page 59 -- discussed Gray's description from a Boie specimen); Schlegel 1837-1844 (D. reinwardtii).

Draco haematopogon microlepis Boulenger

- Synonymy: Boulenger 1912; de Rooij 1915; Hennig 1936a; Smith 1930; Wermuth 1967.
- Description: Boulenger 1893b, 1912; de Rooij 1915; Hennig 1936a, b.
- Distribution: Bartlett 1895; Boulenger 1893b, 1894c, 1903, 1912; de Rooij 1915; de Witte 1933; Hennig 1936a, b; Robinson and Kloss 1915; Smith 1916a, 1930; Suvatti 1950; Wermuth 1967; Werner 1910.
- Specimens identified: Hennig 1936a.
- Environment: Boulenger 1912 (alt.); de Rooij 1915 (alt.).

Draco lineatus Daudin (subspecies unidentified)

Synonymy: Dumeril and Bibron 1837; Wiegmann 1835 (Dracunculus); Hennig 1936a; Wermuth 1967.

Description: Boettger 1892; Dumeril and Bibron 1837; Gray 1831; Kuhl 1820; Schlegel 1837-1844 (ribs, teeth); Wiegmann 1835 (teeth).

Distribution: Boettger 1892, 1893a; Brongersma 1933; de Witte 1933; Dumeril and Bibron 1837; Fitzinger 1826; Kuhl 1820; Laidlaw 1901; Lampe and Lindholm 1901; Mertens 1930; Pfeffer 1962; Schlegel 1837-1844.

Environment: Pfeffer 1962.

Specimens identified: Boettger 1893a; Lampe and Lindholm 1901; Brongersma 1933.

Miscellaneous: Hennig 1936a (doubts presence in New Guinea, defense of lineatus as a subspecies); Wiegmann 1835 (erection of Dracunculus).

Draco lineatus amboinensis Lesson

Synonymy: Gray 1845 (Dracunculus); Hennig 1936a; Wermuth 1967.

Description: Hennig 1936a, b; Lesson 1824.

Distribution: Hennig 1936a, b; Lesson 1824; Wermuth 1967.

Specimens identified: Hennig 1936a.

Comparisons: Hennig 1936a, b.

Draco lineatus beccarii Peters and Doria

Synonymy: Boulenger 1885; de Rooij 1915 (beccarii, walkeri); Hennig 1936a; Smith 1927 (suppression of walkeri); Wermuth 1967.

Description: Boulenger 1885, 1891b (walkeri), 1897 (color plate); de Rooij 1915 (beccarii, walkeri); Peters and Doria 1878 (beccarii m. sp.); Hennig 1936a, b; Kopstein 1927; Smith 1927.

Distribution: Boulenger 1885, (walkeri), 1891b (walkeri), 1894c (walkeri), 1897; de Rooij 1915 (walkeri); Hennig 1936a, b; Kopstein 1927; Laidlaw 1901 (walkeri); Mertens 1930; Peters and Doria 1878; Roux 1911; Smith 1927; Weber 1890 (lineatus Daudin); Wermuth 1967; Werner 1910.

Behavior: Smith 1927, 1935 (courtship).

Eggs: Roux 1911.

Environment: Smith 1927 (on trees in open jungle).

Specimens identified: Boulenger 1894c (walkeri, Brit. Mus.?); Hennig 1936a.

Miscellaneous: Boulenger 1897 (specimens referred to volans and maculatus will, ... turn out to belong to D. beccarii); Smith 1927 (examined only known specimen of walkeri).

Comparisons: Hennig 1936b; Smith 1927 (beccarii and walkeri).

Draco lineatus bimaculatus Gunther

Synonymy: Boulenger 1885 (plate); Hennig 1936a; Taylor 1922b, 1923; Wermuth 1967.

Description: Boulenger 1885; Gunther 1864; Hennig 1936a, b; Tanner 1949; Taylor 1918 (plate), 1922b, 1923.

Distribution: Boulenger 1885; Boettger 1886: Brown and Alcala 1970; Gunther 1879; Hennig 1936a, b; Tanner 1949; Taylor 1918, 1922b, 1923; Wermuth 1967; Werner 1910.

Eggs: Taylor 1922b.

Environment: Taylor 1923.

Miscellaneous: Taylor 1923 (found in same trees as rizali), 1922b (collecting method, feeding on exposed trunks).

Behavior: Tanner 1949 (escape behavior).

Specimens identified: Hennig 1936a; Tanner 1949; Taylor 1922b.

Comparisons: Hennig 1936a, b.

Draco lineatus bourouniensis Lesson

Synonymy: de Jong 1926; Hennig 1936a (lineatus, toxopei, buruensis, bourouniensis); Wermuth 1967.

Description: de Jong 1926 (toxopei, buruensis); Hennig 1936a, b; Lesson 1824.

Distribution: de Jong 1926 (lineatus, toxopei, buruensis); Hennig 1935a, b; Lesson 1824; Peters and Doria 1878; Wermuth 1967.

Comparisons: de Jong 1926 (buruensis and silonotus and ochropterus, toxopei and beccarii); Hennig 1936a (toxopei, buruensis, amboinensis), b.

Specimens identified: Hennig 1936a (also types of buruensis and toxopei).

Draco lineatus lineatus Daudin

Synonymy: Boulenger 1885; de Rooij 1915; Hennig 1936a; Fitzinger 1843 (Dracontoides); Mertens 1936 (D. lineatus de Witte placed as the nominal form into D. l. lineatus); Wermuth 1956; Wiegmann 1835.

Description: Boulenger 1885; de Rooij 1915; Hennig 1936a, b; Mertens 1936; Wiegmann 1935 (Dracunculus).

Distribution: Boulenger 1885; Dammerman 1929; Hennig 1936a, b; Mertens 1936, 1957a; Muller 1892; Van Lidth de Jeude 1893; Wermuth 1967.

Specimens identified: Boulenger 1885; Hennig 1936a.

Comparisons: Hennig 1936a, b.

Draco lineatus modiglianii Vinciguerra

Synonymy: de Rooij 1915; Hennig 1936a; Wermuth 1967.

Description: de Rooij 1915; Hennig 1936a; Vinciguerra 1892.

Distribution: Boulenger 1894c; de Rooij 1915; Hennig 1936a; Vinciguerra 1892; Wermuth 1967; Werner 1910.

Comparisons: Hennig 1936a (with D. l. lineatus); Vinciguerra 1892 (similar to D. lineatus).

Specimens identified: Hennig 1936a; Boulenger 1894c.

Miscellaneous: Hennig 1936a (questions justification of subspecies).

Draco lineatus ochropterus Werner

Synonymy: de Rooij 1915; Hennig 1936a; Wermuth 1967.

Description: de Rooij 1915; Hennig 1936a, b; Werner 1910 (ochropterus).

Distribution: de Rooij 1915; Hennig 1936a, b; Wermuth 1967; Werner 1910 (see also "Celebes", ref. Boulenger 1897);

Miscellaneous: Hennig 1936a (because of sexual dimorphism Werner 1910 separated Kei Isl. specimens into D. lineatus and D. ochropterus n. sp.); Smith and Proctor 1921 (ochropterus separation from lineatus questioned); Werner 1910 (ochropterus may be only a color variation of lineatus).

Specimens identified: Smith and Proctor 1921.

Comparisons: Werner 1910 (near fimbriatus and cristatellus and until this paper cyanolaemus, resembles, in closing "wing membrane", beccarii, lineatus); Hennig 1936a (like D. l. amboinensis), b.

Draco lineatus spilonotus Gunther

Synonymy: Boulenger 1885; de Rooij 1915; Gunther 1872 (spilopterus), 1873 (spilonotus described 1872 in error as spilopterus); Hennig 1936a; Wermuth 1967.

Description: Boulenger 1885, 1897 (plate); de Rooij 1915; Gunther 1864 (rostratus), 1872, 1873; Hennig 1936a, b.

Distribution: Boulenger 1885, 1897; de Rooij 1915; Gunther 1872; Hennig 1936a, b; Muller 1895, (Kema, northern Celebes = D. l. spilonotus' range in Celebes); Peters and Doria 1878; Wermuth 1967; Werner 1910.

Comparisons: Hennig 1936a (with beccarii), b.

Specimens identified: Hennig 1936a.

Miscellaneous: Boulenger 1897 (color differences may cause spilonotus to be compared with lineatus).

Draco maculatus divergens Taylor

Synonymy: Taylor 1963; Wermuth 1967.

Description: Taylor 1934 (plate), 1963.

Distribution: Bourret 1943; Taylor 1934, 1963 (revised type locality); Wermuth 1967.

Specimens identified: Taylor 1943 (types); Malnate 1971.

Comparisons: Taylor 1934 (volans), 1963 (volans affinity incorrect, differentiation from D. m. whiteheadi).

Draco maculatus maculatus (Gray)

Synonymy: Boettger 1893b (haasei); Boulenger 1885, 1890a, 1912; Cantor 1846; Flower 1899; Gunther 1864; Hennig 1936a; Smith 1930, 1935; Taylor 1934 (haasei re-raised to full species), 1963; Taylor and Elbel 1958 (maculatus, haasei); Wermuth 1967.

- Description: Ananyeva 1978 (cutaneous receptors); Boettger 1893b (haasei); Boulenger 1885, 1890a, 1912; Bourret 1937, 1939a; Cantor 1846; George and Shah 1965 (lungs); Gray 1845; Gunther 1864; Henke 1975 (intestinal tract and gliding); Hennig 1936a; Lynn 1966 (thyroid); Mason 1882; Muller 1885 (Java?); Smith 1935; Smith and Kloss 1915 (compares male-female coloring); Taylor 1934 (maculatus, haasei); 1963 (D. m. maculatus, D. m. haasei); Taylor and Elbel 1958 (maculatus, haasei); Werner 1910; Williams 1934.
- Distribution: Biswas 1967; Boettger 1893b (haasei); Boulenger 1885, 1887a, 1893a, 1912; Bourret 1937, 1939a, 1943; Cantor 1846; Cochran 1930; Flower 1896, 1899; Gunther 1864; Hennig 1936a; Laidlaw 1901; Mason 1882; Mell 1929; Pongsapipatana 1975; Pope 1955; Robinson and Kloss 1915; Smith 1915a, 1929, 1930, 1935, 1940; Smith and Kloss 1915 (D. m. haasei); Suvatti 1950 (D. m. haasei); Swarder 1925 (see miscellaneous); Taylor 1934 (haasei, maculatus), 1963 (haasei, D. m. maculatus, D. m. haasei); Taylor and Elbel 1958; Wermuth 1967; Werner 1910.
- Comparisons: Boettger 1893 (haasei and maculatus); Bourret 1939a (divergens and maculatus); Cantor 1846 (maculatus and volans, maculatus and lineatus); Laidlaw 1901 (allied to whiteheadi); Smith 1935 (maculatus haasei, whiteheadi); Taylor 1963 (D. m. haasei related to D. m. maculatus); Taylor and Elbel 1958 (haasei related to maculatus); Wandolleck 1900.
- Specimens identified: Boettger 1893b (haasei); Boulenger 1885; Bourret 1937; Cochran 1930; Flower 1899; Hennig 1936a; Smith and Kloss 1915; Taylor 1934; Taylor and Elbel 1958.
- Environment: Boettger 1893b (haasei, on tree trunks with -- but rarely -- taeniopterus); Bourret 1939a; Flower 1899; Hennig 1936a (alt.); Mell 1929 (high mountains of w. China); Pongsapipatana 1975; Smith 1935 (alt.); Taylor 1963 (alt.); Taylor and Elbel 1958 (haasei, taken on a tree trunk with taeniopterus); Werner 1910 (alt.).
- Eggs: Cantor 1846; Pongsapipatana 1975.
- Behavior: Henke 1975 (gliding correlated with insectivorous feeding); Pope 1955 (use of "wings"); Smith 1935 (combat); Williams 1934 (climbing).
- Sexual dimorphism: Taylor 1963.
- Miscellaneous: Bourret 1939a (variety of maculatus); Smith 1916b, 1930 (commonest flying lizard in Thailand), 1935 (specimens from north of Assam have dorsal scales distinctly larger than those from other parts of Indo-China); Smith and Kloss 1915; Swarder 1925 (Boulenger, 1912, included Singapore in the range, but there are no recent records); Werner 1910 (differences in specimens).

Draco maculatus whiteheadi Boulenger

- Synonymy: Hennig 1936a; Schmidt 1927; Smith 1935 (whiteheadi, maculatus); Taylor 1963; Taylor and Elbel 1958; Wermuth 1967.
- Description: Boulenger 1899 (plate); Colbert 1967 (patagium musculature anatomy, function, and mechanics); Hennig 1936a; Schmidt 1927; Taylor 1963; Taylor and Elbel 1958.

Distribution: Barbour 1909; Boulenger 1899; Bourret 1943; Hennig 1936a; Laidlaw 1901; Schmidt 1927; Smith 1923, 1935; Taylor 1963; Taylor and Eibel 1958; Wermuth 1967; Werner 1910.

Comparisons: Boulenger 1899 (whiteheadi and maculatus); Hennig 1936a (D. m. whiteheadi and D. m. maculatus); Laidlaw 1901 (whiteheadi and maculatus); Schmidt 1927 (whiteheadi and maculatus); Smith 1923 (cannot distinguish whiteheadi from maculatus); Taylor 1963 (similarity to D. m. maculatus); Taylor and Eibel 1958 (whiteheadi and maculatus).

Behavior: Colbert 1967 (patagium function, gliding); Schmidt 1927 (jumping, gliding, protective coloration).

Specimens identified: Schmidt 1927.

Miscellaneous: Schmidt 1927 (tail regeneration); Swinhoe 1870 (Draco sp? = in Schmidt 1927 synonymy).

Draco maximus cryptotis Despax

Synonymy: Hennig 1936a; Wermuth 1967.

Description: Despax 1912; Hennig 1936a.

Distribution: Despax 1912; Hennig 1936a; Mertens 1930; Wermuth 1967.

Comparisons: Despax 1912 (cryptotis, maximus, quinquefasciatus).

Specimens identified: Despax 1912.

Draco maximus maximus Boulenger

Synonymy: Boulenger 1912; de Rooij 1915 (intermedius); Grandison 1972; Hennig 1936a; Smith 1912; Wermuth 1967; Werner 1910 (maximus, intermedius).

Description: Boulenger 1893b (plate), 1912; Colbert 1967; de Rooij 1915 (intermedius, maximus); Grandison 1972; Hennig 1936a; Robinson 1905; Smith 1925; Werner 1910 (intermedius, maximus).

Distribution: Bartlett 1895; Boulenger 1893b, 1894c, 1912; Bourret 1943; Dammerman 1929; de Rooij 1915 (maximus, intermedius); Hennig 1936a; Grandison 1972; Gunther 1895; Robinson 1905; Smith 1925, 1930, 1931; Taylor 1963; Wermuth 1967; Werner 1910 (maximus, intermedius).

Environment: Boulenger 1893b (alt.); Grandison 1972; Gunther 1895 (alt.); Hennig 1936a (alt.); Robinson 1905 (alt.); Werner 1910.

Comparisons: Werner 1910 (intermedius and other species).

Specimens identified: de Rooij 1915; Grandison 1972; Hennig 1936a.

Eggs: de Rooij 1915.

Miscellaneous: Taylor 1963 (not in Thailand but should be looked for there); Boulenger 1903 (cited in Boulenger 1912 synonymy).

Draco melanopogon Boulenger

Synonymy: Bartlett 1895 (nigriappendiculatus n. sp.); Boulenger 1912; de Rooij 1915; Grandison 1912; Hennig 1936a; Smith 1930; Taylor 1963; Taylor and Eibel 1958; Wermuth 1967.

Description: Ananyeva 1978 (cutaneous receptors); Bartlett 1895 (nigriappendiculatus); Boulenger 1887a, 1903, 1912; de Rooij 1915; Grandison 1912; Hendrickson 1955; Hennig 1936a, b; Inger and Greenberg 1966; Smith 1916b; Tanner 1953; Taylor 1963; Taylor and Elbel 1958; Volz 1904.

Distribution: Bartlett 1895 (nigriappendiculatus); Boulenger 1887a, 1903, 1912; Bourret 1943; Cochran 1930; de Rooij 1915; de Witte 1933; Flower 1896, 1899; Grandison 1972; Gunther 1895; Hanitsch 1898; Hendrickson 1966; Hennig 1936a, b; Inger and Greenberg 1966; Laidlaw 1901; Lampe and Lindholm 1901; Smedley 1931; Smith 1916a, 1930; Suvatti 1950; Swarder 1925; Tanner 1953; Taylor 1963; Taylor and Elbel 1958; Volz 1904; Wermuth 1967; Werner 1910.

Comparisons: Hendrickson 1966 (eggs of melanopogon and volans); Lampe and Lindholm 1901 (melanopogon, haematopogon); Hennig 1936a, b.

Eggs: Grandison 1972; Hendrickson 1966; Inger and Greenberg 1966; Taylor 1963; Volz 1904.

Environment: Boulenger 1903 (alt.), 1912; Grandison 1972 (trees, alt.); Hendrickson 1966; Inger and Greenberg 1966; Laidlaw 1901; Swarder 1933.

Behavior: Inger and Greenberg 1966 (reproduction); Klingel 1965 (flight).

Specimens identified: Bartlett 1895 (nigriappendiculatus); Cochran 1930; Flower 1896; Grandison 1972; Hennig 1936a; Tanner 1953; Taylor and Elbel 1958.

Miscellaneous: Boulenger 1912 (next to volans, commonest species in Malay Peninsula); Hendrickson 1966 (does not occur on continental Asia above the Malay Peninsula, collection of 400 Draco from primary forest near Kuala Lumpur was more than 80% melanopogon); Swarder 1933 (easternmost of four Draco -- melanopogon, volans, quinquefasciatus, formosus, but only in primary forest).

Draco norvillii Alcock

Synonymy: Smith 1935; Wermuth 1967.

Description: Alcock 1895 (plate); Smith 1929, 1935, 1940.

Distribution: Alcock 1895; Biswas 1967; Jayaram 1949 (most widely distributed species of the Indo-China subregion); Smith 1929, 1935, 1940; Wermuth 1967; Werner 1910.

Comparisons: Alcock 1895 (blanfordii); Hennig 1936a (taeniopterus, blanfordii).

Miscellaneous: Hennig 1936a (aberrant form of blanfordii).

Draco punctatus Boulenger

Synonymy: Boulenger 1912; de Rooij 1915; Grandison 1972; Hennig 1936a; Smith 1930; Taylor 1963; Wermuth 1967.

Description: Boulenger 1900b, 1903 (fig.), 1912; de Rooij 1915; Grandison 1972; Hennig 1936a; Taylor 1922b, 1963.

Distribution: Boulenger 1900b, 1903, 1912; Bourret 1943; de Rooij 1915; Grandison 1972; Hennig 1936a; Laidlaw 1901; Smith 1916a, 1930; Suvatti 1950; Taylor 1963; Wermuth 1967; Werner 1910.

Environment: Boulenger 1900b (alt.), 1903 (alt. tree), 1912 (alt.); de Rooij 1915 (alt.); Grandison 1972; Smith 1916b; Taylor 1963 (alt.).
 Specimens identified: Grandison 1972; Hennig 1936a; Taylor 1963.
 Miscellaneous: Grandison 1972 (taken from same tree as volans and fimbriatus); Taylor 1922b (males and females vary greatly in color and markings), 1963 (a Bornean specimen included by Hennig 1936a with the type -- restricted type locality is Larut Hills, Penang).
 Comparisons: Boulenger 1903 (crestatellus).

Draco quinquefasciatus longibara Hennig

Synonymy: Wermuth 1967; Hennig 1936a.
 Description: Hennig 1936a.
 Distribution: Hennig 1936a; Wermuth 1967; Obst 1977.
 Specimens identified: Hennig 1936a; Obst 1977 (a type lost in WWII bombing).

Draco quinquefasciatus quinquefasciatus Hardwicke and Gray

Synonymy: Boulenger 1885, 1912; de Rooij 1915; Dumeril and Bibron 1837; Fitzinger 1843; Grandison 1972; Gray 1845 (Dracunculus, Draco); Hardwicke and Gray 1827 (fasciata); Hennig 1936a (viridis Kuhl non Daudin 1803); Smith 1930; Wermuth 1967.
 Description: Bartlett 1895; Boulenger 1885, 1912; Cochran 1930; de Rooij 1915; Dumeril and Bibron 1837; Grandison 1972; Gray 1831 (fasciatus, viridis and fuscus), 1845; Hardwicke and Gray 1827 (fasciata); Gunther 1864; Hennig 1936a, b; Inger and Greenberg 1966; Kuhl 1820, 1824; Stoliczka 1873; Tanner 1953; Taylor 1963.
 Distribution: Bartlett 1895; Boulenger 1885, 1891a, 1912; Bourret 1943; Cochran 1930; de Rooij 1915; Dumeril and Bibron 1837; Flower 1896, 1899; Grandison 1972; Gunther 1864; Hanitsch 1898; Hennig 1936a, b; Inger and Greenberg 1966; Kuhl 1820 (viridis Linn. = volans volans, viridis Kuhl = D. q. quinquefasciatus -- see Wermuth 1967), 1824; Lampe and Lindholm 1901; Mocquard 1890; Smith 1916a, b, 1930; Suvatti 1950; Swarder 1933; Tanner 1953; Taylor 1963; Van Lidth de Jeude 1901; Wermuth 1967; Werner 1910.
 Environment: Grandison 1972; Inger and Greenberg 1966.
 Eggs: Grandison 1972; Inger and Greenberg 1966.
 Specimens identified: Bartlett 1895; Boulenger 1891; Cochran 1930; Dumeril and Bibron 1837; Flower 1896; Grandison 1972; Hennig 1936a; Lampe and Lindholm 1901; Tanner 1953.
 Miscellaneous: Taylor 1963 (two forms recognized -- Malay form and Borneo form).
 Comparisons: Hennig 1936a, b.

Draco spilopterus cornutus Gunther

Synonymy: Boulenger 1885; de Rooij 1915 (cornutus, D. gracilis Barbour); Hennig 1936a; Wermuth 1967.

- Description: Barbour 1903 (gracilis); Bartlett 1895; Boulenger 1885 (plate); de Rooij 1915 (cornutus, gracilis); Gunther 1964; Hennig 1936a; Mocquard 1890; Muller 1890; Smedley 1931; Smith 1931; Taylor 1922b; Van Lidth de Jeude 1893; Volz 1904; Wandolleck 1900; Werner 1910.
- Distribution: Barbour 1903 (gracilis); Bartlett 1895; Boulenger 1885; de Rooij 1915 (cornutus, gracilis); Gunther 1864, 1879; Hennig 1936a; Laidlaw 1901; Mocquard 1890; Muller 1890; Smedley 1931; Smith 1925, 1931; Taylor 1918, 1922b; Van Lidth de Jeude 1893, 1905; Volz 1904; Wermuth 1967; Werner 1910 (cornutus, gracilis).
- Specimens identified: Barbour 1903 (gracilis); Bartlett 1895; Hennig 1936a.
- Environment: Bartlett 1895 (alt.); Smith 1931 (alt.).
- Eggs: de Rooij 1915.
- Comparisons: Gunther 1864 (cornutus allied to volans); Barbour 1903 (gracilis and cornutus).
- Miscellaneous: Bartlett 1895 (native name); Hennig 1936a (Werner's cornutus from Jolo = D. volans, reticulatus); Taylor 1922b (Werner's cornutus from Jolo = rizali).

Draco spilopterus spilopterus (Wiegmann)

- Synonymy: Boulenger 1885 (ornatus); Boettger 1866; de Rooij 1915 (rostratus); Dumeril and Bibron 1837; Fitzinger 1843 (Dracontoides personatus); Hennig 1936a; Taylor 1922b (ornatus); Wandolleck 1900 (ornatus, spilopterus); Wermuth 1967.
- Description: Boulenger 1885 (spilopterus, ornatus, rostratus); Boettger 1893a (quadrasi); de Rooij 1915 (rostratus); Dumeril and Bibron 1837; Gray 1845 (Dracunculus ornatus); Gunther 1873 (spilonotus, spilopterus); Hennig 1936a, b; Schlegel 1837-1844; Taylor 1922b (quadrasi, spilopterus, ornatus); Wiegmann 1835 (Dracunculus).
- Distribution: Bartlett 1895 (rostratus); Boettger 1886 (ornatus), 1893a (spilopterus, quadrasi, ornatus); Boulenger 1885 (ornatus); 1894c (quadrasi); Brown and Alcala 1970 (quadrasi, ornatus); Dumeril and Bibron 1837; Gunther 1872, 1879; Hennig 1936a, b; Laidlaw 1901 (rostratus); Muller 1884; Schlegel 1837-1844; Schmidt 1935; Tanner 1949; Taylor 1917 (ornatus), 1922b (ornatus); Wermuth 1967; Werner 1910 (quadrasi, ornatus, rostratus, spilopterus).
- Comparisons: Boettger 1893a (quadrasi maculatus and bimaculatus, quadrasi and spilopterus), 1886 (fimbriatus); Hennig 1936a (cornutus, volans), b; Schlegel 1837-1844 (lineatus, viridis); Gunther 1873 (volans, ornatus); Taylor 1922b (quadrasi and spilopterus).
- Specimens identified: Boettger 1893a; Boulenger 1894c; Tanner 1949; Taylor 1922b (quadrasi); Hennig 1936a.
- Food: Taylor 1922b.
- Behavior: Schmidt 1935 (courtship).
- Miscellaneous: Hennig 1936a (support of synonymization of ornatus, quadrasi and rostratus); Taylor 1922b ("Werner's opinion that Draco ornatus is the female of Draco spilopterus is certainly incorrect", variations among specimens of spilopterus and of quadrasi); Schlegel 1837-1844 (Dracunculus).

Draco taeniopterus indochinensis Smith

Synonymy: Hennig 1936a; Smith 1935; Wermuth 1967.

Description: Hennig 1936a; Smith 1928, 1935.

Distribution: Hennig 1936a; Smith 1928, 1935; Wermuth 1967.

Specimens identified: Smith 1928, 1935.

Environment: Smith 1928 (alt.).

Comparisons: Smith 1928 (indochinensis and taeniopterus Gunther), 1937 (indochinensis and blanfordii).

Miscellaneous: Smith 1937 (disagreement with Hennig on indochinensis as a subspecies).

Draco taeniopterus taeniopterus Gunther

Synonymy: Boulenger 1885, 1890a; de Rooij 1915; Hennig 1936a; Smith 1930, 1935; Taylor 1963; Wermuth 1967.

Description: Boulenger 1885, 1890a; Cochran 1930; de Rooij 1915; Flower 1898; Gunther 1861; Hennig 1936a, b; Mason 1882; Smith 1930, 1935, 1937 (plate); Smith and Kloss 1915; Taylor 1963.

Distribution: Bartlett 1895; Boulenger 1885, 1887a, 1890a; Bourret 1939b, 1943; Cochran 1930; de Rooij 1915; Flower 1899; Hanitsch 1898; Hennig 1936a, b; Mason 1882; Mocquard 1890; Morice 1975; Smith 1916a, 1930, 1935; Smith and Kloss 1915; Suvatti 1950; Taylor 1963 (practically the same distribution as D. m. maculatus); Wermuth 1967; Werner 1910.

Environment: Bartlett 1895 (alt.); de Rooij 1915 (alt.); Morice 1875.

Specimens identified: Bartlett 1895; Cochran 1930; Taylor 1963.

Eggs: Taylor 1963.

Behavior: Klingel 1965 (flight ... as in volans, melanopogon).

Comparisons: Hennig 1936a (Wandolleck's Java taeniopterus = haematopogon), b; Smith 1930 (formosus), 1935 (de Rooij's Borneo specimen confused with closely allied formosus), 1937 (formosus, blanfordii); Taylor 1963 (eggs similar to eggs of blanfordii).

Draco volans linnaeus

Synonymy: Boulenger 1885 (volans, reticulatus), 1912; de Rooij 1915 (volans, reticulatus); Gray 1845; Gunther 1864; Taylor 1922b (volans, reticulatus).

Description: Bartlett 1895; Baumann 1913; Boulenger 1885 (volans, reticulatus, plate), 1912; Cantor 1846; Cochran 1930; de Rooij 1915 (volans, reticulatus); Flower 1896, 1899; Gunther 1864; Lederer 1933; Linnaeus 1758; Lynn 1966; Owen 1866 (vertebrae, ribs); Roux 1911; Siebenrock 1895 (skeleton, teeth); Smith 1935 (hyoid); Taylor 1922b (volans, reticulatus); Volz 1904; Wiegmann 1835.

Distribution: Alcala 1966; Bartlett 1895; Boettger 1892, 1893a; Boulenger 1885 (volans, reticulatus), 1887a, 1890b, 1894a, b, 1897, 1903, 1912; Brongersma 1933; Brown and Alcala 1961, 1964, 1970; Cantor 1846;

- Cochran 1930; Dammerman 1929; de Rooij 1915 (volans, reticulatus); Despax 1912; Dunn 1927; Elbert 1912; Flower 1896, 1899; Gunther 1864, 1895; Hanitsch 1898; Hendrickson 1966; Kopstein 1930a, b; Laidlaw 1901 (volans, reticulatus); Lampe and Lindholm 1901; Mertens 1929, 1960a; Mocquard 1890; Peters and Doria 1878 (reticulatus); Pfeiffer 1962; Ridley 1899; Roux 1911; Siebenrock 1895 (Java); Smedley 1932; Smith 1916a, b, 1925, 1930; Stoliczka 1873; Suwatti 1950; Sworder 1925; Taylor 1922b (volans, reticulatus); Van Lidth de Jeude 1901; Weber 1890; Werner 1910.
- Specimens identified: Bartlett 1895; Boulenger 1885; Brongersma 1933; Cochran 1930; Dunn 1927; Lampe and Lindholm 1901; Smith 1930.
- Behavior: Alcalá 1966 (ecology, longevity, growth, sexual maturity), 1967 (ecology, breeding, nesting, thermal physiology, sexual maturity, activity); Alcalá and Brown 1967 (growth rate); Boulenger 1912 (ref. to Flower's description of activity); Cantor 1846; Flower 1896; Hairston 1957 (ecology, activity); Kreff 1904; Lederer 1933; Petzold 1974; Savile 1962 (courtship and gliding); Tweedie 1954; Bopp 1954 (after Werner in Boker 1935).
- Eggs: Alcalá 1966, 1967; Boulenger 1912; Cantor 1846; Flower 1896; de Rooij 1915; Hendrickson 1966; Kopstein 1930a; Laidlaw 1901; Saint-Girons 1956; Volz 1904.
- Food: Alcalá 1967; Bogert 1954; Cantor 1846; Mertens 1929; Ridley 1899.
- Gliding: Alcalá 1967; Boulenger 1912; Boker 1935 (volans, reticulatus); Flower 1896; Klingel 1965; Hairston 1957; Laidlaw 1901; Mertens 1929, 1959a, 1960a; Schmidt 1960; Pennycuik 1972.
- Environment: Bartlett 1895; Bogert 1954; Boulenger 1887a (alt.), 1897 (alt.), 1912; Brongersma 1947; Brown and Alcalá 1961, 1964; Cantor 1846; Cochran 1930; de Rooij 1915 (volans, reticulatus); Hendrickson 1966; Kopstein 1930b (alt.); Laidlaw 1901; Mertens 1929; Volz 1904.
- Comparisons: Gunther 1873 (ornatus and volans).
- Sexual dimorphism: Alcalá 1967.
- Miscellaneous: Alcalá 1967 (predators and parasites, toe clipping and regeneration, longevity, male-female-juvenile ratios); Bogert 1954 (general notes, activity, patagium); Boulenger 1903 (sex distinguished by color of gular appendages); Brown and Alcalá 1970 (introduced species); Bustard 1960; Cochran 1930 (native name); Elbert 1912 (Lombok species belongs to Indian form); Flower 1896 (difficult to see when at rest; in air, colorful), 1899 (native name); Hendrickson 1966 (does not occur on continental Asia above Malay Peninsula); Klynstra 1959 (care and response in captivity); Kreff 1904 (general observations); Lafrentz 1914 (structure, embryology, physiology, theory of glide); Petzold 1974 (behavior in captivity); Ridley 1899 (ecology, behavior, food, general notes); Smith 1916b (reference to D. volans from Sai Yok; Smith 1916a in error, animal is D. maculatus); Sworder 1925; Taylor 1922b (reticulatus not seen, exact type locality unknown).

Draco volans boschmai Hennig

Synonymy: Hennig 1936a; Mertens 1930 (D. v. reticulatus); Wermuth 1967.
Description: Hennig 1936a, b; Weber 1890 (reticulatus).

Distribution: Dammerman 1926 (reticulatus); Dunn 1927 (reticulatus); Hennig 1936a, b; Pfeffer 1962 (reticulatus); Weber 1890 (reticulatus); Wermuth 1967; Werner 1910 (reticulatus).
 Specimens identified: Hennig 1936a; Dunn 1927 (reticulatus); Mertens 1930 (D. v. reticulatus).
 Comparisons: Hennig 1936a (D. v. reticulatus of Mertens and subsp. justification), b.
 Miscellaneous: Obst 1977 (type material lost in WWII bombing of Dresden).

Draco volans reticulatus Gunther

Synonymy: Boettger 1886 (reticulatus var. cyanoptera); Hennig 1936a; Mertens 1930 (volans reticulatus n. ssp.); Obst 1977 (rizali type lost during bombing of Dresden, WWII); Taylor 1922b (everetti, guentheri); Wermuth 1967.
 Description: Boulenger 1885 (everetti, plate, guentheri), 1897; Focart 1954; Gunther 1864 (n. sp.); Hennig 1935a, b; Mertens 1930; Taylor 1918 (rizali), 1922b (guentheri, everetti, rizali); Wandolleck 1900 (rizali).
 Distribution: Beottger 1886 (guentheri, everetti), 1893a (guentheri, everetti); Boulenger 1885 (everetti, guentheri); Brown and Alcala 1970 (rizali, everetti); Focart 1953; Gunther 1864; Hennig 1936a, b; Mertens 1930; Pfeffer 1959; Taylor 1922b (everetti, rizali); Wandolleck 1900 (rizali); Wermuth 1967; Werner 1910 (rizali, everetti, guentheri).
 Specimens identified: Boettger 1893a (guentheri, everetti); Focart 1953; Hennig 1936a; Mertens 1930; Schuz 1929 (rizali); Taylor 1922 (rizali).
 Environment: Boulenger 1897 (alt.); Focart 1953; Mertens 1930; Taylor 1918 (rizali), 1922b.
 Food: Taylor 1922b.
 Gliding: Mertens 1930.
 Comparisons: Hennig 1936a (volans volans, dussumieri), b; Mertens 1930 (D. v. volans and D. v. reticulatus and geographic separation, timorensis); Werner 1910 (guentheri and volans).
 Miscellaneous: Hennig 1936a (Werner 1910 has under the name cornutus from Jolo in Hamburg Museum a D. v. reticulatus); Mertens 1930 (Flores species of timorensis = D. v. reticulatus).

Draco volans timorensis Kuhl

Synonymy: Boulenger 1885; de Rooij 1915; Dumeril and Bibron 1837; Fitzinger 1843; Gray 1841; Hennig 1936a; Van Lidth de Jeude 1895 (D. viridis var. samaoensis); Wermuth 1967.
 Description: Boulenger 1885; de Rooij 1915; Dumeril and Bibron 1837; Hennig 1936a, b; Gray 1831; Kuhl 1820; Manacas 1956; Schlegel 1837-1844 (D. viridis var. samaoensis); Van Lidth de Jeude 1895; Werner 1910.
 Distribution: Boulenger 1885, 1898; de Rooij 1915; Dumeril and Bibron 1837; Dunn 1927; Ferreira 1898; Fitzinger 1826; Hennig 1936a, b;

Kuhl 1820; Laidlaw 1901; Manacas 1956; Thermido 1941; Van Lidth de Jeude 1895; Wermuth 1967; Werner 1910.
 Comparisons: Dumeril and Bibron 1837 (D. daudinii); Schlegel 1837-1844 (D. viridis var. samaoensis and D. v. timorensis); Van Lidth de Jeude 1895 (D. viridis var. samaoensis); Werner 1910 (spilopterus); Hennig 1936a, b.
 Eggs: de Rooij 1915; Van Lidth de Jeude 1895.
 Food: Manacas 1956.
 Specimens identified: Boulenger 1885; Hennig 1936a; Dunn 1927.
 Miscellaneous: Dunn 1927 (native name).

Draco volans volans Linnaeus.

Synonymy: Dumeril and Bibron 1837 (D. daudinii); Fitzinger 1843 (viridis Daudin); Grandison 1972; Hennig 1936a; Linnaeus 1766; Mertens 1930, 1936; Taylor 1963; Wermuth 1967.
 Description: Dumeril and Bibron 1837 (D. daudinii); Grandison 1972; Hardwicke and Gray 1827 (viridis Daudin); Hennig 1935a, b; Kuhl 1820 (fuscus); Kuhl and van Hasselt 1822 (viridis); Laurenti 1768 (major, minor); Schlegel 1837-1844 (viridis, viridis var. sumatrana); Taylor 1963.
 Distribution: Bourret 1943; Dumeril and Bibron 1837 (D. daudinii); Fitzinger 1826 (viridis); Hennig 1936a, b; Grandison 1972; Hardwicke and Gray 1827 (viridis); Kopstein 1938; Kuhl 1820 (fuscus); Kuhl 1820 (fuscus); Kuhl and Hasselt 1822 (viridis); Laurenti 1768 (major, minor); Mertens 1930, 1934b, 1936, 1957a, b, 1959b; Muller 1882, 1892; Schlegel 1837-1844 (viridis var. sumatrana, viridis var. javanica); Swarder 1933; Taylor 1963; Wermuth 1967.
 Behavior: Alcalá 1967 (ecology, display); Grandison 1972; Swarder 1933.
 Comparisons: Dumeril and Bibron 1837 (dragon vert and dragon brun); Hennig 1936a, b; Mertens 1930 (D. v. volans and D. v. reticulatus); Schlegel 1937-1844 (viridis var. sumatrana and D. v. javanica).
 Eggs: Grandison 1972; Kopstein 1938; Swarder 1933 (eggs and nesting).
 Environment: Grandison 1972 (alt.); Pfeffer 1962; Kopstein 1938 (alt.); Swarder 1933.
 Specimens identified: Grandison 1972; Hennig 1936a; Mertens 1930, 1959b; Taylor 1963.
 Miscellaneous: Grandison 1972 (same tree with f. fimbriatus and punctatus); Swarder 1933 (latex clogging appendages and upright position).

Draco Linnaeus

Synonymy: Blumenbach 1832 (Lacerta volans); Boulenger 1885, 1912; Gray 1845; Hennig 1936a; Fitzinger 1843 (Draco, Dracontoides, Rhacodracon, Pterosaurius, Pleuropterus); Linnaeus 1758; Rafinesque 1815 (Draconus); Savage 1961 (Draco Oken, D. ocellatus, Intl. Rules Zool. Nomencl.); Taylor 1922b; Taylor and Elbel 1958; Smith 1935; Wiegmann 1834 (Dracunculus); Wermuth 1967.

- Description:** Boulenger 1885, 1890a, 1912; Colbert 1967; de Rooij 1915; Dumeril and Bibron 1837; Etheridge 1967; Gray 1831; Hennig 1936a, b; Hoffmann 1878 (tarsals); Laurenti 1768; Lesson 1824 (plate); Loveridge 1945 (fig.); Mason 1882; Mertens 1960a; Pfeffer 1962; Schlegel 1837-1844; Schmidt and Inger 1957; H. Schmidt 1960; Scortecci 1941 (receptor/end organs); Siebenrock 1895 (skeleton, teeth); Smith 1935, 1938; Steindachner 1895 (skeleton); Taylor 1922a, b, 1963; Tweedie 1956; Wandolleck 1900.
- Distribution:** Boker 1935; Boulenger 1912; de Rooij 1915; Hennig 1936a, b; Herre 1958; Jayaram 1949; Leiker 1953 (not in New Guinea); Mertens 1930; Nadchatram 1971 (Malay); Schmidt and Inger 1957; Smith 1935; Taylor 1928; Taylor and Elbel 1958; Wermuth 1967; Werner 1910.
- Environment:** Bogert 1954 (highest treetops); Gray 1845; Jayaram 1949; Laidlaw 1910 (alt.); Lesson 1824 (forests); Pfeffer 1962; H. Schmidt 1960.
- Gliding:** Bogert 1954; Boker 1935; Colbert 1967; Deninger 1910; Freiberg 1954; Gunther 1864 (series of leaps); Henke 1975; Herre 1958; Lesson 1824; Loveridge 1945; Mertens 1959a, 1960b; Oliver 1951; Pfeffer 1962; Savile 1962; H. Schmidt 1960; Schmidt and Inger 1957; Smith 1935; Taylor 1922b, 1963; Tweedie 1956; Werner 1912.
- Behavior:** Jayaram 1949 (arboreal); Krefft 1904; Pfeffer 1962; Schiotz and Volsoe 1959; Schmidt and Inger 1957; Smith 1935; Taylor 1963; Tweedie 1956.
- Food:** Henke 1975; Jayaram 1949; Lesson 1924; Mertens 1934a; Pfeffer 1962; Taylor 1963; Tweedie 1956.
- Eggs:** Kopstein 1938; Lesson 1824 (trunk of trees); Loveridge 1945; Smith 1935; Taylor 1922b (trees), 1963; Tweedie 1956, 1960; Tweedie and Harrison 1954.
- Sexual dimorphism:** Hennig 1936a (common).
- Specimens identified:** Hennig 1936a; Obst 1977; Taylor 1963; Wandolleck 1900.
- Miscellaneous:** Cantor 1847 (native name); Colbert 1967 (evolution); Daudin 1802 (species separated by "wings"); Hennig 1936a (development of markings and patterns and relation to geographic distribution, species differentiation, patagium configurations), b; Krefft 1904 (general observations); Kuhl 1820 (5 species recognized); Laidlaw 1901 (species differentiation, geographic differentiation, native names); Lesson 1824 (3 species recognized); Mertens 1960b (about 15 species); Pfeffer 1962 (native name, observations); Pope 1955 (about 40 species); Savage 1961 (Bull. Zool. Nomencl.); Schmidt and Inger 1957 (about 15 species); Smith 1916b (more males than females); Swinhoe 1870 (native collecting and use, native name); Taylor 1922b (observation and notes, native names, shedding), 1963 (notes); Wandolleck 1900 (plates of occipital and snout regions of 11 species); Werner 1910 (37 species + *D. affinis* which he doesn't count since he can't find the publication by Bartlett -- see bibliography below for correct citation); Wandolleck 1900 (list of species).

KEYS AND SYNOPSES

Alcock 1895; Boulenger 1885, 1887a, 1890a (India and Burma species), 1897 (reticulatus, spilonotus, beccarii), 1912 (Malay Peninsula species); Bourret 1943 (Indochina species); de Rooij 1915; Dumeril and Bibron 1837; Fitzinger (Draco, Dracontoides, Rhacodracon, Pterosaurus, Pleuropterus); Gray 1845 (Draco, Dracoceila, Dracunculus); Gunther 1864; Hennig 1935a; Laidlaw 1901 (geographic division of species); Loveridge 1945; Smith 1935, 1937 (taeniop-terus, formosus, blanfordii); Taylor 1922b (Philippine Isl. species), 1963 (Thailand species); Taylor and Elbel 1958 (Thailand species); Wiegmann 1834 (Draco and Dracunculus); Werner 1910 (tabular presentation of blanfordii and formosus).

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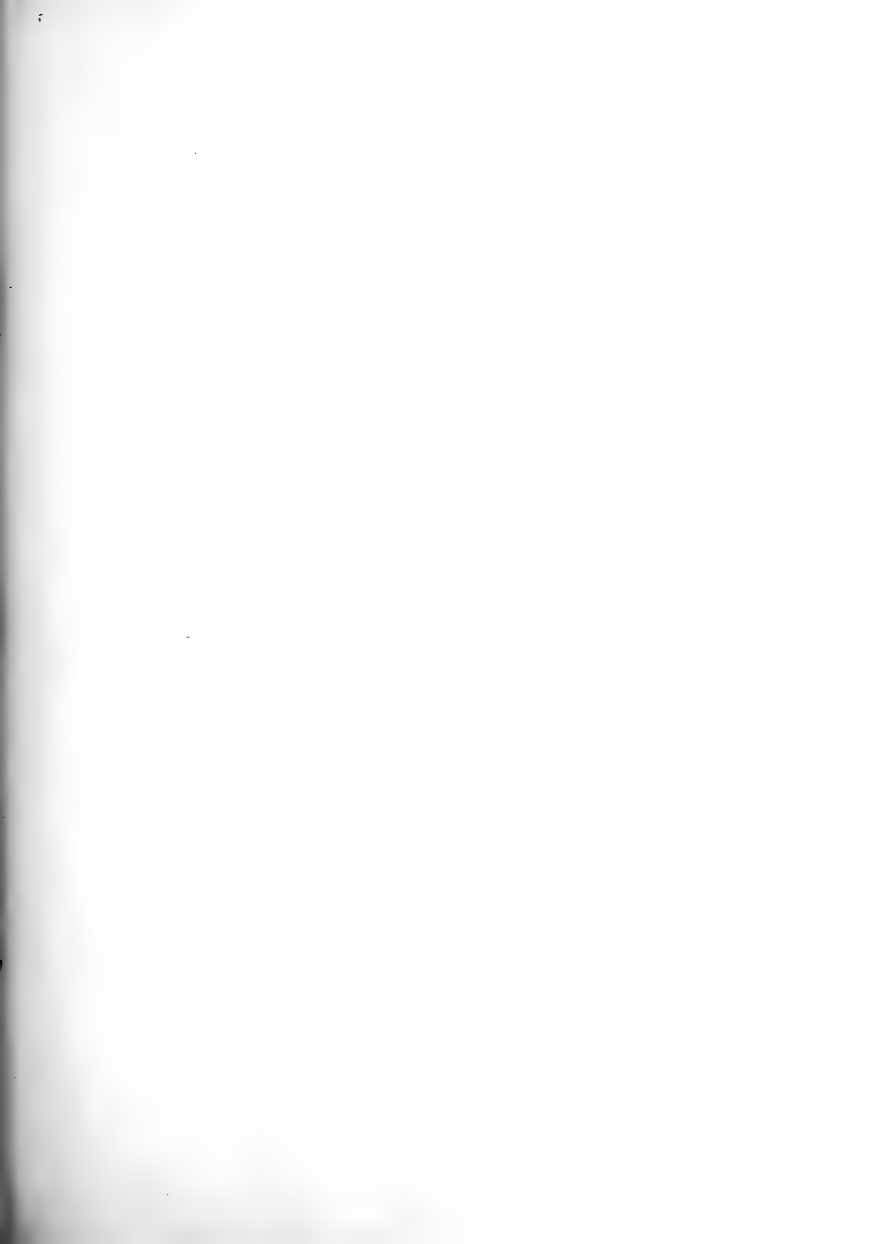
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A ANNOTATED BIBLIOGRAPHY
OF THE
GENUS CNEMIDOPHORUS IN NEW MEXICO



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INTRODUCTION

The Teiid lizard genus Cnemidophorus attains its highest diversity in North America within the borders of the state of New Mexico. Lizards of this genus are dominant components of the terrestrial fauna, yet their biology is only now being understood. Indeed, with one notable exception, little was known about the North American species twenty years ago except that they were highly confusing taxonomically. Then, this genus was discovered to be unique among vertebrates with its high proportion of unisexual taxa. Fully one-half of the forms in New Mexico are obligate parthenospecies; each of these is derived from hybridization events between two or more sexual species of the genus. They are clonally diverse in some cases, perhaps all; that is, they manifest genetic and morphological variability somewhat approaching that of sexual species although localized populations are usually quite homogeneous. The ecological and evolutionary interactions of these parthenospecies with each other, and with their sexual congeners, is only now being detailed.

One cannot study this genus without coming to grips with the labyrinthine snarl of its taxonomy. Systematic solutions have spanned the gamut from minute detailing of non-significant variation to simply ignoring differences. The genus is a diverse one, and much of the confusion resulted from an unawareness of hybrid parthenogenetic clones within it. Morphological characters can be more or less variable in clones than in sexual populations, depending upon the character and the scope of the examination. The parthenospecies considered here do present a taxonomic problem. The biological species concept, which requires free intraspecific exchange of genetic material, obviously does not apply to them. They just as obviously exist. How does one deal with them on a taxonomic basis? Again, solutions ranged from giving each separate clone specific rank to taxonomically ignoring them. I agree with Maslin, Wiley and others that each successful parthenogenetic clone does have an evolutionary life span and with the modification of Simpson's evolutionary species concept to include them. I propose a further step. One has to know what organisms one is dealing with in order to do biology well. This is part of the fundamental utility of the biological species concept, yet it has not been applied to parthenogenetic Cnemidophorus without ambiguity, confusion, and controversy. The capability exists, detailed in this bibliography, to identify the parental sexual species of each parthenospecies of Cnemidophorus. I propose that a given species name be applied and restricted to a particular combinatorial sequence, past, present or future, of successful hybridization events. Thus, the name Cnemidophorus neomexicanus will be uniquely applied to clones originating from C. inornatus X C. tigris events. This will obviate the necessity of applying multiple names to a clonal species complex (Zweifel's pattern class system will serve admirably in this regard) and of naming (or ignoring) aberrant individuals representing chance hybrid events that do not represent successful populations. Most important, I believe this scheme

provides an evolutionary foundation to the nomenclature of parthenogenetic Cnemidophorus, which can only aid in the understanding of their biology. I believe that C. dixonii is not a valid parthenospecies based on these criteria. It was originally erected on the basis of color pattern and ecological differences, which are not sufficient criteria for recognizing species. It is obviously a C. tessellatus clone, with its own particular ecological requirements and evolutionary history, and differing no more from other clones of that species than they do from each other. I believe that C. dixonii should be, and will do so formally in a future paper, relegated to the synonymy of C. tessellatus.

It is apparent that each species, sexual or parthenogenetic, has its own particular set of ecological requirements and, given historical factors, will occur wherever these requirements are satisfied. These requirements are not yet fully understood and appear to lead to a bewildering array of discontinuous, overlapping species assemblages. It is also apparent that at least some parthenospecies have had multiple origins but that not every hybridization event has generated a successful parthenogenetic population because aberrant individuals representing probable hybrids are collected regularly. The cytogenetic criteria necessary for parthenogenetic reproduction are not understood. The ecological conditions required for parthenogenetic populations to succeed are beginning to be investigated; this bibliography provides a body of uncorrelated data and opinion on that subject. The species of Cnemidophorus in New Mexico provide a rich, fertile ground for the study of many biological phenomena. I believe that the species themselves and their interactions can be utilized as excellent indices of present habitat type, condition and environmental quality, and that of the historically recent past. Much interesting and potentially significant field work remains undone.

The following index is a numerical listing of the annotations by species. Parthenospecies are designated (P). A citation number is placed after a particular subspecies name when it is known definitively that that subspecies is referred to; otherwise the number is placed after the general species name. Correct species names are placed in parentheses in the text following names that are no longer in use or that are incorrectly applied. The bibliography is not exhaustive; I have omitted such as the popular Field Guides which are readily available to everyone, and works of a purely taxonomic nature which are either useless or not pertinent to the scope of this work. The bibliography is nevertheless complete; it represents the sum total of the knowledge on the species of Cnemidophorus that occur in New Mexico.

ACKNOWLEDGEMENTS

I wish to thank Holly Reynolds and the Interlibrary Loan Staff at New Mexico State University for graciously tracking down obscure and/or hard-to-get papers. Dr. C. J. McCoy of the Carnegie Museum of Natural

History also helped in this regard, as well as providing encouragement. I particularly wish to thank Wirt and Valerie Atmar, and AICS, Box 4691, University Park, Las Cruces, New Mexico, for the use of a System 2000 Terminal and Word Processor with which this bibliography was composed. Most importantly, I wish to thank my wife Weslyn and son Alec for their kindness and tolerance. I thank her and Wirt Atmar for their efforts on the cover illustration. This bibliography was done under contract 519-70-06 for the Endangered Species Program, New Mexico Department of Game and Fish, and I thank Bill Baltosser in particular for his help and consideration.

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Cnemidophorus tigris tigris hosted Odontacarus arizonensis and Eutrombicula belkini. Areas of greatest infestation were in the directions of fallout from nuclear detonations.

2. Anderson, R. A. and W. H. Karasov. 1981. Contrasts in energy intake and expenditure in sit-and-wait and widely foraging lizards. *OECOLOGIA (BERLIN)* 49(1): 67-72.

Daily energy metabolism and water flux were measured with doubly labeled H₂O in free-living Cnemidophorus tigris in the Colorado Desert of California. 91% of the 5-hour active day is spent in movement. The costs of free existence were calculated from the difference between field metabolism rates and maintenance costs estimated in the laboratory. C. tigris was found to be energy efficient.

3. Asplund, K. K. 1970. Metabolic scope and body temperatures of whiptail lizards (Cnemidophorus). *HERPETOLOGICA* 26(4): 403-411.

Individual Cnemidophorus tigris, when active near the eccentric body temperature, (1) consume over 2 cc of oxygen per gram-hour, more than a resting mammal of the same size, (2) attain body temperatures 1-2 degrees Centigrade above ambient if they weigh 80-100 grams. These properties are similar to but much greater than those of varanid lizards. Thermogenesis (muscular activity) could play a role in the thermal ecology and habitat selection of macroteiid lizards.

4. —. 1974. Body size and habitat utilization in whiptail lizards (Cnemidophorus). *COPEIA* 1974(3): 695-703.

This study involved field and laboratory manipulations of subspecies of Cnemidophorus tigris of varying sizes, including C. tigris gracilis. Whiptails have the highest known sustained rates of oxidative metabolism among reptiles. Body size plays a relatively direct role in determining the thermospatial niche of these lizards. Larger lizards bask less and spend more of their activity period in the shade than do smaller lizards with the same thermal preferences and tolerance limits. Variation of body size in Cnemidophorus may reflect adaptation

to differences in desert vegetation structure; relatively larger lizards being more successful in relatively shaded habitats. Small body size may be of selective advantage during decreases in vegetation density or during increases in the extremes or instabilities of climate.

5. Axtell, R. W. 1959. Amphibians and reptiles of the Black Gap Wildlife Management Area, Brewster County, Texas. SOUTHWESTERN NATURALIST 4(2): 88-109.

The area is described and ecological differences between Cnemidophorus inornatus heptagrammus and C. tigris marmoratus are discussed.

6. —. 1961. Cnemidophorus inornatus, the valid name for the Little Striped Whiptail, with the description of an annectant subspecies. COPEIA 1961(2): 148-158.

The nomenclatural confusion surrounding the lizard now known as Cnemidophorus inornatus is reviewed. The subspecies C. i. inornatus and C. i. heptagrammus (occurs in our area) are formally named, diagnosed, and described. Their respective habitats and distributions are discussed, and range maps are provided.

7. —. 1966. Geographic distribution of the unisexual whiptail Cnemidophorus neomexicanus (Sauria: Teiidae)—Present and past. HERPETOLOGICA 22(4): 241-253.

The taxonomic history of the species is briefly reviewed, and a detailed range map is provided. Ecological attributes and interactions of this species with others in the genus are discussed in detail. Two presumed hybrids between C. neomexicanus and C. inornatus are described. The geographic fragmentation of southern populations of C. neomexicanus is explained in light of the geologic history of the area and a Wisconsin or pre-Wisconsin time of origin is suggested for the species.

8. —. 1977. Ancient playas and their influence on the recent herpetofauna of the northern Chihuahuan Desert. in TRANSACTIONS OF THE SYMPOSIUM ON BIOLOGICAL RESOURCES OF THE CHIHUAHUAN DESERT REGION, UNITED STATES AND MEXICO. Wauer, R. H. and D. H. Riskind, editors. National Park Service Trans. and Proc. Series, No. 3: 493-512.

The geomorphic history of the region in Chihuahua and New Mexico is considered in detail. Western range margins of Cnemidophorus tessellatus and C. tigris marmoratus, southern range margins of C. inornatus

and C. neomexicanus (map presented), and eastern range margins of C. tigris gracilis appear to have been influenced by various lacustrine barriers. Records for C. neomexicanus in the Jornada del Muerto, but not in the Elephant Butte Basin, support contentions that the ancestral Rio Grande once flowed through the former; Quaternary basalt flows in the middle Jornada are believed to have diverted it westward through the Elephant Butte Gap.

9. — and R. G. Webb. 1963. New records for reptiles from Chihuahua, Mexico, with comments on sympatry between two species of Cnemidophorus. SOUTHWESTERN NATURALIST 8(1): 50-51.

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10. Ayala, S. C. and J. J. Schall. 1977. Apparent absence of blood parasites in southwestern Texas Cnemidophorus. SOUTHWESTERN NATURALIST 22(1): 134-135.

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Values of caloric and water content for eggs of Cnemidophorus gularis and C. sexlineatus are given. The determination of reproductive effort is briefly discussed.

12. — and C. O. McKinney. 1968. Occurrence of a patternless morph of Cnemidophorus. HERPETOLOGICA 24(3): 264-265.

A photograph and description of Cnemidophorus tigris marmoratus from Crane County, Texas, is given.

13. —, J. W. Nietfeldt and J. J. Krupa. 1979. An experimental analysis of the role of the tail in attaining high running speed in Cnemidophorus sexlineatus (Reptilia: Squamata: Lacertilia). HERP. 35: 114-116.

Running speed was reduced by an average of 36% by removing tails in lizards collected in Nebraska. Tail autonomy occurs less frequently and less easily in lizards that utilize speed for escape, such as this species, than in species that utilize tail-breakage for escape.

14. —. and G. D. Schrank. 1972. Reproductive potential of female whiptail lizards, Cnemidophorus gularis gularis. HERP. 28: 217-222.

The reproductive cycles and size and age at maturity are discussed for a population near San Angelo, Texas. As many as 50% of the females do not mature until their second reproductive season. Those that mature during their first season do so late and lay one clutch of 3-4 eggs. Older females lay 2 clutches per year averaging 5 eggs each.

15. Barbault, R. 1977. Etude comparative des cycles journaliers d'activite des lezards Cophosaurus texanus, Cnemidophorus scalaris et Cnemidophorus tigris dans le desert de Mapimi (Mexique). BULLETIN SOCIETE ZOOLOGIQUE DE FRANCE 102(2): 159-168.

C. tigris is active on a daily basis in July between 0900 and 1700 hours with peak activity occurring at 1300 hours. Activity graphs presented show the species to be more active on cloudy than sunny days. Cloacal temperatures of active lizards average 37.13°C. with average air and soil temperatures of 27.46°C. and 34.76°C., respectively. It is suggested that density estimates based on line transect data be made over many days and times of varying environmental conditions to be valid.

16. —, C. Grenot et Z. Uribe. 1978. Le partage des ressources alimentaires entre les especes de lezards du desert de Mapimi (Mexique). TERRE ET VIE 32(1): 135-150.

Cnemidophorus tigris and C. inornatus are optimally specialized to eat termites, but are essentially opportunistic feeders with highly diversified and largely overlapping diets. C. inornatus avoids competition by living in a specialized microhabitat (Hilaria mutica communities).

17. —. and M.-E. Maury. 1981. Ecological organization of a Chihuahuan desert lizard community. OECOLOGIA 51(3): 335-342.

This study investigates niche relationships among the 11 main diurnal insectivorous species of the lizard community in the Mapimi desert near Ceballos, Durango, Mexico. C. inornatus and C. tigris were

among the species studied. Time of activity, habitat, and food were the niche gradients measured. There appears to be a high overlap between C. tigris and the third teiid species present, C. scalaris. Close observation of their ecologies at a finer level reveals many small differences between them, and these are examined. They may be assumed to be potentially competitive. Frequent interspecific aggressive encounters occur in the field in which C. tigris always chases C. scalaris away. It is suggested that in a highly heterogeneous, unpredictable ecosystem like the Mapimi the small ecological differences mentioned greatly facilitates the coexistence of these two species. It is further suggested that the very diversified ecological opportunism of C. scalaris allows it to colonize periodically the ecosystem where C. tigris is dominant in only a small number of biotopes.

18. Barden, A. 1942. Activity of the lizard, Cnemidophorus sexlineatus. ECOLOGY 23(3): 336-344.

Laboratory experiments were done on lizards from Kansas and Indiana to elucidate potential parameters controlling activity. Activity rhythms are partially endogenous and partially controlled by environmental factors such as light and temperature, with increasing day length implicated as triggering spring emergence from hibernation.

19. Beargie, K. M. L. 1971. The cranial morphology of the Teiid genus Cnemidophorus. PH.D. DISS., UNIV. OF COLORADO. 175 p.

The abstract is not informative, but the work is probably pertinent to this report. The author cannot afford to purchase it, and the University of Colorado will not lend the work.

20. Benes, E. S. 1969. Behavioral evidence for color discrimination by the whiptail lizard, Cnemidophorus tigris. COPEIA 1969(4): 707-722.

12 lizards, C. t. mundus and C. t. tigris, were trained to feed against a background of colored discs. The lizards were divided into two equal groups and individuals were presented with a pair of discs from which to feed. One group fed undisturbed from red discs and was given an electric shock when attempting to feed from green ones; the other group underwent the reverse procedure. The initial disc pair was quite divergent in color; the pairs became closer and closer in color to each other on successive trials. The lizards in each group learned from which color disc they could feed successfully. Red colors tend to be less acceptable and green colors more difficult to learn to reject than the reverse situation. Cnemidophorus tigris can make fine distinctions in color differences and is also capable of a generalized color reaction. It is suggested that warning colors of unpalatable prey can

be associated with unpalatability or noxiousness with experience by the lizard and that the association formed could also be transferred to other not necessarily unpalatable insect species of similar colors.

21. Bickham, J. W. and J. A. MacMahon. 1972. Feeding habits of the Western Whiptail Lizard, Cnemidophorus tigris. SOUTHWESTERN NATURALIST 17(2): 207-208.

An analysis of the stomach contents of a seasonally restricted, small sample from a single locality south of Phoenix, Maricopa County, Arizona, is presented.

22. —, C. O. McKinney and M. F. Mathews. 1976. Karyotypes of the parthenogenetic whiptail lizard Cnemidophorus laredoensis and its presumed parental species (Sauria, Teiidae). HERPETOLOGICA 32(4): 395-399.

Karyotypes of C. laredoensis, C. gularis and C. sexlineatus from Texas are presented and compared, and the data are consistent with the hypothesis that the latter two are indeed the parental species.

23. Bissinger, B. E. and C. A. Simon. 1979. Comparison of tongue extrusions in representatives of six families of lizards (Reptilia, Lacertilia). JOURNAL OF HERPETOLOGY 13(2): 133-139.

Tongue-flick values are given for Cnemidophorus exsanguis, C. tessellatus and C. tigris. The combined value for the Teiids is significantly higher than any of the other lizard families studied. It is suggested that this correlates with a lack of development of visual communication in this family and importance of the tongue-Jacobson's Organ system in feeding behavior and other types of communication.

24. Bogert, C. M. 1949. Thermoregulation in reptiles, a factor in evolution. EVOLUTION 3(3): 195-211.

Cnemidophorus tessellatus (= C. tigris) collected in August and September in Pinal County, Arizona, had cloacal body temperatures of $41.3 \pm .24^{\circ}\text{C}$. at air and substrate temperatures of $33.6 \pm .43^{\circ}\text{C}$. and $41.3 \pm 1.07^{\circ}\text{C}$., respectively. This body temperature approximates that of a rodent of similar bulk, and this lizard is as active and probably remains seasonally as active as a mammal with similar hibernation needs.

25. Bowker, R. G. 1980. Sound production in Cnemidophorus gularis. JOURNAL OF HERPETOLOGY 14(2): 187-188.

Laboratory studies show that lizards when disturbed emit a short, monosyllabic squeak that can be heard by the teiid ear. A sonagram is presented.

26. —. and O. W. Johnson. 1980. Thermoregulatory precision in 3 species of whiptail lizards (Lacertilia: Teiidae). PHYSIOLOGICAL ZOOLOGY 53(2): 176-185.

Field and laboratory data are presented for Cnemidophorus gularis, C. inornatus and C. uniparens. Mean body temperatures measured in the field were not significantly different between species; however, C. uniparens had the highest value yet was collected under the coldest field conditions. C. inornatus had the intermediate value yet was collected under the hottest field conditions. C. gularis had the lowest value yet was collected under hotter field conditions than C. uniparens. Mean body temperatures measured in artificial thermal gradients were not significantly different between species; C. uniparens > C. gularis > C. inornatus. Thermoregulatory behavior is described and heating and cooling rates given for each species. Lizards heat faster than they cool. Precise control of body temperature is achieved by shuttling back and forth from warm to cool areas in the thermal gradients. C. uniparens is significantly more precise than the other two species; this implies that it spends more time thermoregulating. Behavior is shown to be very important in thermoregulation. Field studies of thermoregulation are suggested.

27. Brackin, M. F. 1978. The relation of rank to physiological state in Cnemidophorus sexlineatus dominance hierarchies. HERP. 34: 185-191.

Laboratory studies of lizards from Oklahoma show that rank is closely related to body weight and aggressiveness. High-ranking males readily tried to mate with females whereas low-ranking males did not; this behavior was directly proportional to testicular condition. Feeding behavior and nutritive condition were not related to rank; adrenal volume was inversely proportional to rank. The significance of these finding to individual fitness in wild populations requires further study.

28. —. 1979. The seasonal reproductive, fat body, and adrenal cycles of male Six-lined Racerunners (Cnemidophorus sexlineatus) in central Oklahoma. HERPETOLOGICA 35(3): 216-222.

The breeding season begins in late May; testes are hypertrophic

and sperm production and fat body depletion commences. Adrenal gland volume increases to reach a maximum during the summer, which initiates intraspecific aggressive and sexual behavior. The breeding season ends in late July with opposite responses of the above attributes.

29. **Brian, B. L., F. C. Gaffney, L. C. Fitzpatrick and V. E. Scholes.** 1972. Fatty acid distribution of lipids from carcass, liver and fat bodies of the lizard, Cnemidophorus tigris, prior to hibernation. COMPARATIVE BIOCHEMISTRY AND PHYSIOLOGY 41(3B): 661-664.

Lizards were collected in late August from El Paso County, Texas. Females had a larger mean fat body weight. Fat bodies contained the highest percentage of lipids (66-97), while liver and carcass ranges were 10-48 and 2-14, respectively. A list of fatty acids identified (8 total) is given.

30. **Brown, W. M. and J. W. Wright.** 1979. Mitochondrial DNA analyses and the origin and relative age of parthenogenetic lizards (genus Cnemidophorus). SCIENCE 203: 1247-1249.

Analyses of mitochondrial DNA's (which are inherited maternally) and their endonuclease digestion products confirm the hybrid origins of Cnemidophorus neomexicanus and diploid C. tessellatus. C. tigris mar-moratus is indicated as the maternal parent species in both cases. The data imply that these two parthenospecies are younger than some races of Cnemidophorus tigris.

31. **Bull, J.** 1978. Sex chromosome differentiation: an intermediate stage in a lizard. CANADIAN JOURNAL OF GENETICS & CYTOLOGY 20(2): 205-210.

G- and C-banding of both meiosis and mitosis in Cnemidophorus tigris show that the X and Y chromosomes are homologous but do not cross over in the centromere region, where they differ in centric position and heterochromatin.

32. **Busack, S. D. and R. B. Bury.** 1974. Some effects of off-road vehicles and sheep grazing on lizard populations in the Mojave Desert. BIOLOGICAL CONSERVATION 6(3): 179-183.

Cnemidophorus tigris populations were markedly depressed in grazed areas in contrast to ungrazed ones. Both lizard numbers and lizard biomass were down in ORV use areas compared to non-ORV use areas.

33. Carpenter, C. C. 1959. A population of the Six-lined Racerunner (Cnemidophorus sexlineatus). HERPETOLOGICA 15(2): 81-86.

Seasonal activity, growth rates and movement patterns of a population in Oklahoma were noted. Behavioral observations were made and it was concluded that the population was a stable one with little immigration or emigration.

34. —. 1960a. Aggressive behavior and social dominance in the Six-lined Racerunner (Cnemidophorus sexlineatus). ANIMAL BEHAVIOUR 8: 61-66.

Laboratory and field observations were made on a population in Oklahoma. Lizards were not territorial, but formed social hierarchies. Aggressive behavior is described. 1 or 2 lizards established themselves as dominants in groups formed in the laboratory. Males were usually dominant over females; the smallest lizards were the most subordinate. Dominant lizards were more active over longer periods of time in both the lab and the field. This may serve to regulate population densities, dominant individuals assuring themselves of an adequate food supply by driving subordinate individuals to less favorable habitats.

35. —. 1960b. Reproduction in Oklahoma Sceloporus and Cnemidophorus. HERPETOLOGICA 16(3): 175-182.

Egg-laying behavior, clutch size and incubation times are given for Cnemidophorus sexlineatus viridis.

36. —. 1962. Patterns of behavior in two Oklahoma lizards. AMERICAN MIDLAND NATURALIST 67(1): 132-151.

Sexual and agonistic behaviors of both free-ranging and enclosed populations of Cnemidophorus sexlineatus are described in detail. This species is non-territorial but establishes and maintains social hierarchies. This behavior is seen as the result of the species occupying an essentially two-dimensional habitat.

37. Christiansen, J. L. 1969. Notes on hibernation of Cnemidophorus neomexicanus and C. inornatus (Sauria: Teiidae). J. HERP. 3: 99-100.

Observations on individuals of both species excavated from burrows in Albuquerque are given, along with climatological data.

38. —. 1969. Reproduction in Cnemidophorus inornatus and C. neomexicanus. PH.D. DISS., UNIVERSITY OF NEW MEXICO. 247 p.

The only piece of information not contained in the following report is the tendency of individuals of both species to seek refuge in a particular burrow even if they have "to run through a gauntlet of collectors" to get there. This implies that lizards are highly sedentary, that individuals are resident in a particular area. There is no indication of intraspecific territoriality in either species, however.

39. —. 1971. Reproduction of Cnemidophorus inornatus and Cnemidophorus neomexicanus (Sauria, Teiidae) in northern New Mexico. AMERICAN MUSEUM NOVITATES No. 2442: 1-48.

Cnemidophorus inornatus inhabits primarily undisturbed desert grasslands in the Albuquerque region whereas C. neomexicanus is found chiefly in disturbed areas, often man-related, and is able to survive under nearly metropolitan conditions. The two species are reproductively isolated by their habitat preferences, reinforced by the aggressive nature of C. neomexicanus towards C. inornatus. The two species manifest similar seasonal activities. C. inornatus males are more active early in the year and females are more active late in the year. Adults of both species cease surface activity by the third week in September and juveniles by the first week of October. Lizards emerge from hibernation in mid-April; juveniles are more active than adults for a few weeks in spring and before hibernation begins in the fall. The male reproductive cycle of C. inornatus is described. Maximum testicular size is achieved in April and maximum sperm production occurs in May through the first week of June. Minimum testicular size occurs in late July-early August and growth occurs throughout the winter. The fat body cycle is approximately the reverse. The female reproductive cycle is nearly identical for both species. Follicular enlargement of up to 3 per lizard begins in April-May, the first ovulations occur in the last week of May through the first week of June, and eggs are laid from the first week of June through the third week of July (peaks in mid-June). Approximately 25% of the females of both species lay a second clutch. The mean clutch size for both species is 2.13, but ovarian follicles and oviducal eggs are considerably larger in C. neomexicanus. The first hatchlings appear in the last two weeks of July, and new hatchlings continue to appear until the first week of September. Individuals of both species can live for 4 calendar years; 25% possibly live for 5. Individuals are not reproductively mature until their 3rd calendar year. C. neomexicanus populations possess double the reproductive potential of C. inornatus populations by virtue of parthenogenesis; it is suggested that the viability of eggs of the former species is only 1/2 that of the latter, although no evidence for this exists in this situation. The displacement of C. inornatus by C. neomexicanus is

attributed to the aggressive nature of the latter, its preference for disturbed habitats (which are increasing), and its ability to reproduce in areas where the food supply cannot support two individual lizards.

40. —. 1973. Natural and artificially induced oviducal and ovarian growth in two species of Cnemidophorus (Sauria: Teiidae). HERPETOLOGICA 29(3): 195-204.

The parthenogenetic species (C. neomexicanus) is identical to the normal species (C. inornatus) in both the natural histological changes of the oviduct and those induced by hormones. Lizards were collected in Albuquerque.

41. —. and W. G. Degenhardt. 1969. An unusual variant of the whip-tail lizard Cnemidophorus gularis (Sauria, Teiidae) from New Mexico. TEXAS JOURNAL OF SCIENCE 21(1): 95-97.

A morphologically variant specimen was collected from dense mesquite within the city limits of Carlsbad. It is compared to the 10 known specimens from the state, and to 10 specimens of C. exanguis selected because of superficial similarity to the variant. It is concluded that the specimen is a good C. gularis.

42. —, —. and J. E. White. 1971. Habitat preferences of Cnemidophorus inornatus and Cnemidophorus neomexicanus with reference to conditions contributing to their hybridization. COPEIA 1971(2): 357-359.

Habitat preferences for both species within Albuquerque are described. C. inornatus was found almost exclusively in dense grass. C. neomexicanus was found only in sparsely vegetated areas and areas with large herbs and shrubs, and was closely associated with man-made objects such as trash piles, hedgerows, ditches and fences. Areas where preferred microhabitats come into close enough proximity to permit inter-specific contact are described. Hybrids from these areas are described.

43. —. and A. J. Ladman. 1968. The reproductive morphology of Cnemidophorus neomexicanus X Cnemidophorus inornatus hybrid males. JOURNAL OF MORPHOLOGY 125(3): 367-378.

Morphometric analyses support the contention that the 6 specimens are indeed hybrids. Histology of the gonads and epididymides is described; notable differences between the hybrids and normal males is discussed. Sperm produced by the hybrids appear to be viable; potential gametogenic abnormalities resulting from their incorporation in a zygote

are discussed.

44. Clark, D. R., Jr. 1976. Ecological observations on a Texas, USA, population of Six-lined Racerunners, Cnemidophorus sexlineatus (Reptilia, Lacertilia, Teiidae). JOURNAL OF HERPETOLOGY 10(2): 133-138.

The activity season lasts from April until October in Brazos County. Most females lay 2, some lay 3, clutches per year averaging 3.38 eggs. Females reach reproductive maturity at 1 year of age. Population turnover is essentially annual although some individuals did survive the winter. Home ranges for both sexes were similar and averaged 13099 m². Year to year climatic fluctuations affected population densities, estimated at 15-24 lizards per hectare, and home range sizes.

45. Cole, C. J. 1975. Evolution of parthenogenetic species of reptiles. in INTERSEXUALITY IN THE ANIMAL KINGDOM. Reinboth, R., editor. Springer-Verlag, Berlin & New York. pp. 340-355.

The origin and evolution of parthenospecies is discussed in a general review article. The species of Cnemidophorus discussed include dixoni, exsanguis, flagellicaudus, neomexicanus, sonorae, tesselatus, uniparens and velox. Problems suggested for study include determination of the egg activation mechanism(s), elucidation of the chromosomal mechanism of sex determination, problems involving gene dosage compensation (as different ploidy levels are involved in Cnemidophorus parthenospecies), the influences of mutation rates on parthenospecies compared to sexual ones, and ecological interactions between parthenoforms and sexual species.

46. —. 1979. Chromosome inheritance in parthenogenetic lizards and evolution of allopolyploidy in reptiles. J. OF HEREDITY 70: 95-102.

Cnemidophorus exsanguis, C. sonoreae and C. tigris from Arizona and New Mexico were raised and crossed in the laboratory. C. exsanguis from Alamogordo represent two distinct karyotypes (= clones) and these are inherited precisely as demonstrated by rearing several generations from each one in the lab. C. sonoreae (3N) X C. tigris (1N) produced a viable tetraploid hybrid. The origin of parthenogenetic Cnemidophorus through hybridization and earlier conclusions on the evolution of allopolyploidy in reptiles is confirmed.

47. —, C. H. Lowe and J. W. Wright. 1969. Sex chromosomes in Teiid whiptail lizards, genus Cnemidophorus. AMERICAN MUSEUM NOVITATES 2395: 1-14.

This paper reports an X-Y (XY=male, XX=female) sex chromosome mechanism in Cnemidophorus tigris gracilis and points out that most species in the genus lack readily recognizable heteromorphic pairs of chromosomes.

48. —. and C. R. Townsend. 1977. Parthenogenetic reptiles: new subjects for laboratory research. EXPERIENTIA 33(3): 285-289.

A detailed description of laboratory procedures necessary to successfully raise parthenospecies of Cnemidophorus through multiple generations is given. C. exsanguis was used primarily, and raised through 4 generations. Other species mentioned were neomexicanus, sonorae, tesselatus and velox, as well as the sexual species inornatus, sexlineatus, and tigris. The significance of this capability for future biological research is discussed.

49. Congdon, J. D., L. J. Vitt and N. F. Hadley. 1978. Parental investment: comparative reproductive energetics in bisexual and unisexual lizards, genus Cnemidophorus. AMERICAN NATURALIST 112: 509-521.

Reproductive energetics for C. inornatus, C. sonorae, C. tigris and C. uniparens from Arizona were estimated from caloric whole body and egg content. Clutch size was larger in unisexual species and in larger species within a reproductive type. Calories/mg. of eggs were not correlated with either body size or reproductive type; differences in clutch volume between species superceded differences in caloric content of eggs per unit weight. Mean calories per egg were higher in large-bodied lizards and in bisexual lizards independent of size. The clutch calories/body calories ratio was significantly higher in unisexual species, and this fact is discussed. Data suggest that the nature of the competitive environment and the degree of genetic similarity among individuals are important evolutionary determinants of the apportionment of energy to reproduction and the compromise between egg size and numbers in whiptail lizards.

50. Crews, D. and K. T. Fitzgerald. 1980. Sexual behavior in parthenogenetic lizards (Cnemidophorus). PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES USA 77(1): 499-502.

Captive Cnemidophorus tessellatus, C. uniparens and C. velox exhibit behavior patterns remarkably similar to the courtship and copulatory behavior of closely related sexual species. The courted animal was reproductively active in each instance while the courting animal was either reproductively inactive or postovulatory. This behavior may represent a nonfunctional vestige of sexual ancestry or be necessary to

normal ovarian functions by replacing male stimuli.

51. Cuellar, H. S. 1978. Continuance of circannual reproductive refractoriness in pinealectomized parthenogenetic whiptails (Cnemidophorus uniparens). J. OF EXPERIMENTAL ZOOLOGY 206(2): 207-214.

The pineal organ does not play a role in the endogenous circannual reproductive cycle of this lizard but may be involved in thermoregulation.

52. —. 1979. Disruption of gestation and egg-shelling in deluteinized oviparous whiptail lizards Cnemidophorus uniparens (Reptilia, Teiidae). GENERAL & COMPARATIVE ENDOCRINOLOGY 39(2): 150-157.

Corpora lutea evidently function to control gravidity and shelling in this reptile and a corpus luteum hormone is probably responsible for this control. An undescribed ovulation behavior and its possible hormonal control is also discussed.

53. —. and O. Cuellar. 1977a. Absence of gonadal refractoriness in the lizards Cnemidophorus uniparens and Sceloporus graciosus. COPEIA 1977(1): 185-188.

The results suggest that the physiology of sexual refractoriness in C. uniparens (collected in Socorro County, NM) is mediated by the neuroendocrine system.

54. —. and —. 1977b. Evidence for endogenous rhythmicity in the reproductive cycle of the parthenogenetic lizard Cnemidophorus uniparens (Reptilia: Teiidae). COPEIA 1977(3): 554-557.

Lizards from Socorro County, New Mexico, were maintained in captivity under either short (10L:14D) or long (14L:10D) photothermal regimes. Some lizards from both groups experienced two consecutive reproductive cycles. This demonstrates the existence of an endogenous circannual rhythm in the reproductive cycle of this species.

55. —. and —. 1977c. Refractoriness in female lizard reproduction: a probable circannual clock. SCIENCE 197(4302): 495-497.

Postreproductive Cnemidophorus uniparens maintained under free-running conditions of constant darkness for 7 months became reproductive

at the same time as controls exposed to long photoperiods. This confirms that the refractory period (a pause in reproductive activity commencing in late summer in nature) is under endogenous control.

56. Cuellar, O. 1968. Additional evidence for true parthenogenesis in lizards of the genus Cnemidophorus. HERPETOLOGICA 24(2): 146-150.

The reproductive tracts and associated organs were examined in both sexual and parthenogenetic species of Cnemidophorus, including exsanguis, neomexicanus, tesselatus, tigris, uniparens and velox. The fact that 6 of 9 bisexual females had spermatozoa in their reproductive tracts while all 36 of the unisexual females lacked similar evidence of courtship, reasonably excludes gynogenesis, a cryptic male behavior, and differential male and female activity periods as interpretations for the all-female condition, and supports true parthenogenesis as the most probable mechanism. Seminal receptacles were absent in both the bisexual and unisexual lizards examined. Sex ratios reported for natural populations of bisexual species of Cnemidophorus are biased in favor of males. This may explain the lack of seminal receptacles in these species. An excess of males might serve the same function as stored sperm, namely to insure a maximum realization of reproductive potential.

57. —. 1970. Egg transport in lizards. J. MORPHOLOGY 130: 129-136.

The morphological cycle of the ovaries and oviducts is examined in individuals of Cnemidophorus exsanguis, C. inornatus, C. neomexicanus, C. tessellatus, C. tigris, C. uniparens and C. velox throughout the reproductive period. Ovaries proceed from a regressed state to a point where they are isolated from the coelom by encapsulating oviducts. An intimate association is established between the oocytes and the infundibular oviductal ostia. Photomicrographs are presented.

58. —. 1971. Reproduction and the mechanism of meiotic restitution in the parthenogenetic lizard Cnemidophorus uniparens. J. MORPHOLOGY 133(2): 139-166.

Live capture methods and captive maintenance techniques for specimens from Arizona and New Mexico are discussed at length. The Bosque del Apache (Socorro Co., NM) population exhibited a mean clutch cycle of 23 days, with a mean number of 3.3 ova per clutch. The reproductive season in nature terminates at the end of July. Chromosomal and cellular behavior associated with egg production is examined in great detail. Parthenogenesis in this species is of the meiotic type. The somatic number of chromosomes is doubled early in oogenesis presumably by a pre-meiotic endoduplication, and the 3N level is restored by 2 subsequent maturation divisions.

59. —. 1974. On the origin of parthenogenesis in vertebrates: the cytotenetic factors. *AMERICAN NATURALIST* 108(963): 625-648.

The evidence for and against the hybridization theory (hybridization-->diploid unisexuality-->polyploidy) and the spontaneous origin theory (ability to produce unreduced ova is genetically acquired-->diploid unisexuality-->polyploidy) is reviewed. Cuellar is biased in favor of the latter, which states that hybridization does not result directly in parthenogenesis but only favors it through heterosis. The evidence presented actually supports both theories; that is to say, neither theory can be ruled out depending on the individual circumstance. The evidence supports the hybridization theory in Cnemidophorus, in the opinion of this reviewer.

60. —. 1976. Intraclonal histocompatibility in a parthenogenetic lizard: evidence of genetic homogeneity. *SCIENCE* 193(4248): 150-153.

A total of 175 skin grafts were transplanted among 20 individuals belonging to two separate populations of Cnemidophorus uniparens. Only intraclonal (= locality) transplants were done. 99.8% were permanently accepted, which indicates that all individuals of each population may be genetically identical. These results further suggest that large populations or the entire species may consist of one clone derived from a single individual. All allografts done with C. tigris (a sexual species), using the same procedures, are eventually rejected. Histocompatibility genes are discussed and it is suggested that the technique described here could be used to determine actual mutation rates in parthenogenetic clones, provided that mutant individuals exist and can be detected.

61. —. 1977a. Genetic homogeneity and speciation in the parthenogenetic lizards Cnemidophorus velox and Cnemidophorus neomexicanus: evidence from intraspecific histocompatibility. *EVOLUTION* 31(1): 24-31.

This study was conducted to determine more precisely the degree of variation in histogenes within and between populations to understand as nearly as possible the extent of genetic variation throughout the range of a parthenogenetic species, and thus perhaps shed further light on the probable origins of parthenogenesis. C. velox, with a wide geographic range, and C. neomexicanus, with a restricted geographic range, were used. Lizards of the latter species, from 4 separate localities encompassing 160 miles of the species' range, underwent intra- and interlocality skin transplants. 99+% of the grafts were retained, implying that the lizards over this geographic area are genetically identical. Lizards of the former species from 2 localities in Utah, 1 in Colorado, and 2 in New Mexico were subjected to the same procedure. All intra-locality grafts were accepted, as well as interlocality grafts between the 2 clones in Utah and the 2 in New Mexico. All interlocality grafts

between clones from different states were rejected, however. This implies that the species has been derived de novo several times, or that a single clone has "speciated" in different parts of its range. This work supports current thought in genetics that environmental and genetic uniformity are correlated.

62. —. 1977b. Animal parthenogenesis: a new evolutionary-ecological model is needed. *SCIENCE* 197(4306): 837-843.

It is suggested that the weed hypothesis concerning parthenogenesis in Cnemidophorus is correct, but not the claim for distinct habitats for each species within the broad geographic "weed" area, as each such habitat is a local climax formation and not weedy. It is suggested that those parthenospecies for which specific habitats are proposed exhibit distinct riparian-dwelling affinities. Theories and models of obligatory parthenogenesis are reviewed. There are three compelling reasons for believing that parthenogenetic species can only evolve in isolation from the generating bisexuals: hybridization by males of congeneric species would impede clone establishment, competition would impede clone expansion, and present distributions show largely distinct habitats between congeneric unisexual and bisexual species. Hence, it is reasonable to assume that parthenogenesis evolves either at the periphery of the range, or if within the range, in areas periodically devoid of the generating species. It is suggested that parthenogenetic species rely on novel habitats, and that the availability of habitat is the key to success, not the meiotic ability to produce unreduced eggs. The salient feature of the distribution of several species of unisexual Cnemidophorus (exsanguis, neomexicanus, tesselatus, uniparens and velox) is the tendency to be floodplain dwellers. Range maps of neomexicanus and tesselatus in relation to drainage patterns are presented. These 5 species also occupy climax communities, but usually where bisexual species are absent. C. inornatus, a bisexual species, is an exception; it occurs sympatrically with several unisexuals in disturbed areas. Conversely, the bisexual C. tigris is almost exclusively restricted to adjacent climax communities characterized by sandy soils. In certain localities of southern New Mexico (in the vicinity of Elephant Butte Reservoir and the Rio Grande) it occurs abundantly in mixed mesquite-creosote associations, but is virtually absent from adjacent pure stands of creosote growing in gravelly soils. Edaphic conditions appear to be important.

The significance of disturbed habitats to parthenogenesis in other kinds of animals is reviewed, along with the displacement of bisexual species by unisexuals. Cytogenetic factors are important in the evolution of parthenogenesis. It is suggested that parthenogenesis is more advantageous in non-territorial rather than territorial animals because the latter would expand too slowly to take advantage of disclimax situations. This explains the absence of unisexual species of birds and mammals; they are so vagile that sexual species would recolonize disturbed areas too rapidly for unisexuals to establish themselves. Clone succession is proposed as better-adapted clones replace less-adapted

ones in particular situations. It is suggested that newly-disturbed areas open to either reproductive mode would be occupied by bisexual species until the origin of a parthenogenetic clone, which would then displace the bisexuals due to its higher intrinsic rate of increase. Selection would promote the survival of clones more or less specially adapted to unique communities of perpetually disturbed areas or areas not occupied by bisexual species. Termination of the physical or climatic conditions promoting and maintaining recurrent disclimax ecologies would cause the extinction of the parthenoforms and the reinvasion of climax communities. Assuming that hybridization gave rise directly to parthenogenetic species is cautioned against. The acceptable corollary to this, in the opinion of this reviewer, is that not every hybridization event leads to the establishment of a successful parthenoform (i.e. C. perplexus); the cytogenetic and ecological factors must synergize.

63. —. 1979. On the ecology of coexistence in parthenogenetic and bisexual lizards of the genus Cnemidophorus. AMER. ZOOLOG. 19: 773-786.

The question of why so many congeneric species of this genus are found together and exactly what their ecological and geographical requirements are remains virtually unanswered. Sympatry among 7 species of Cnemidophorus (exsanguis, inornatus, neomexicanus, tesselatus, tigris, uniparens and velox) is documented and discussed for several localities (mostly in New Mexico), and the first field experiment dealing with competitive interactions between a parthenogenetic and a bisexual species is reported. Short-term habitat alteration and collecting pressures are implicated as factors affecting the interactive demographics of the above species; in some cases the only species involved are parthenogenetic. Collecting can apparently wipe out populations of several of the parthenospecies if sustained and steady over a period of years. The field experiment involved the bisexual species C. tigris and the unisexual species C. uniparens. The former species dominates in mesquite-creosote habitats near Elephant Butte Reservoir whereas the latter occurs in all habitats from the river to the foothills of the San Mateo Mountains. C. tigris is absent from all habitats in the Rio Grande floodplain. The study site is a weedy field between Tamarix and Populus forests which is adjacent to and interdigitates with C. tigris habitat; C. uniparens is dominant here. This species was selectively removed for a period of several days in each of the years 1975, 1976 and 1978. C. tigris failed to invade this habitat although it could do so easily; it was instead repopulated by C. uniparens from the adjacent gallery forests. The mean size of individuals of this species declined as did the number of reproductives, however. Only 3 individual C. tigris were seen, indicating that this species is actively avoiding the riparian zone. The area was visited again in 1979, when this paper was in proof, and the C. uniparens population was identical in density and mean individual size to the previous year. Individuals predominated on the edges of the field rather than the center, indicating invasion from the periphery. 14 different individuals of C. tigris were seen distri-

buted throughout the clearing, indicating an invasion of this species in the absence of a stable population of C. uniparens. It is concluded that perhaps direct competition is a critical factor in this situation after all.

64. —. 1981. Long-term analysis of reproductive periodicity in the lizard Cnemidophorus uniparens. AMER. MIDLAND NAT. 105(1): 93-101.

Reproductive cycles were monitored in captives for their entire lives. The annual cycle of a short reproductive period followed by a long non-reproductive period persisted indefinitely in 80% of the animals. The cycle was reduced to 5 months in the absence of environmental cues. The number of clutches laid per individual remained relatively constant, suggesting that it, like the reproductive rhythm, is under endogenous control. There is evidence for multiple clutches during the reproductive period in nature, followed by a long refractory period. The refractory periods progressively shorten in captivity until they become indistinguishable from between-clutch intervals, implying environmental control of the refractory period. Sexual behavior between captive individuals of parthenogenetic Cnemidophorus reported by Crews and Fitzgerald (1980) is discussed, and evidence suggests that it is abnormal behavior associated with captivity.

65. —. and C. O. McKinney. 1976. Natural hybridization between parthenogenetic and bisexual lizards: detection of uniparental source by skin grafting. JOURNAL OF EXPERIMENTAL ZOOLOGY 196(3): 341-350.

Skin grafting and electrophoresis was done to determine the parental species of suspected natural hybrids in Cnemidophorus. Six species (exsangui, inornatus, neomexicanus, tesselatus, tigris and uniparens) were sympatric in an area 40' by 200' dominated by weedy vegetation along the railroad right-of-way 3 miles south of San Antonio, Socorro County, New Mexico. A stable creosotebush community existed on one side of the area and agricultural lands on the other. C. inornatus occurred in very high densities in the area as did the unisexual species, resulting in increased chances for hybridization. C. tigris was characteristic of the creosote community and rare in the hybrid zone. 50% of the neomexicanus exhibited the characteristic bite marks inflicted during copulation in Cnemidophorus. The hybrid specimens (2 inornatus X uniparens and 3 inornatus X neomexicanus) were superficially morphologically similar to the unisexual parent but possessed bluish undersides. Known hybrids in the genus are reviewed; 25 are males, 7 are females and 4 were not sexed. Skin grafting is suggested as a technique for determining parental species.

66. —. and C. Smart. 1977. Analysis of histo-incompatibility in a

natural population of the bisexual whiptail lizard Cnemidophorus tigris. TRANSPLANTATION 24(2): 127-133.

Abrupt and gradual rejections occurred in a graded sequence in lizards from Utah, suggesting that large numbers of genes and/or alleles are responsible for antigenic properties of skin.

67. —. and —. 1979. The genetics of transplantation in the lizard Cnemidophorus tigris. IMMUNOGENETICS 9(2): 109-118.

The experiments provided a graded sequence of rejection of skin grafts and indicated that the relative degree of antigenicity of a donor was more or less proportional to its immune response. Probable genetic models for rejection are discussed.

68. Culley, D. D., Jr. and H. G. Applegate. 1967. Pesticides at Presidio. IV. Reptiles, birds, and mammals. TEX. J. SCIENCE 19: 301-310.

6 different pesticides were found in specimens of Cnemidophorus inornatus, C. tessellatus and C. tigris collected within a 30 mile radius of Presidio, Presidio County, Texas. Pesticide concentrations in lizards increased from June through August. Lizard eggs contained up to 5 times the concentration found in the gravid female. 2 more male C. tessellatus were collected (3 out of 7 now known come from this area).

69. Dawson, W. R. 1967. Interspecific variation in physiological responses of lizards to temperature. In: LIZARDECOLOGY: A SYMPOSIUM. W. W. Milstead, editor. University of Missouri Press. pp. 230-257.

Data are given on whole animal and tissue oxygen consumption and activity temperatures for Cnemidophorus inornatus and C. tigris.

70. —. and T. L. Poulson. 1962. Oxygen capacity of lizard bloods. AMERICAN MIDLAND NATURALIST 68(1): 154-164.

Data are given for Cnemidophorus inornatus (10.8 volume %), C. sacki (= sonorae, 11.6 volume %), and C. tigris gracilis (9.6 volume %) from Cochise County, Arizona. Data are related to altitude and active body temperatures, and compared to other lizards and higher vertebrates.

71. Degenhardt, W. G. 1966. A method of counting some diurnal ground lizards of the genera Holbrookia and Cnemidophorus with results from the

Big Bend National Park. AMERICAN MIDLAND NATURALIST 75(1): 61-100.

Cnemidophorus tigris marmoratus is among the species discussed. The topography and climate of the area is discussed in detail, along with earlier herpetological investigations. A method of estimating lizard densities by counting active lizards is developed and compared with some poor attempts by the investigator to do the same by live-trapping. Sources of error are discussed. Six study plots were established along an elevational transect and studied for 2 years. A highly significant correlation of lizard numbers with elevation was established. The corollary contributions of vegetation structure, soil, rainfall and temperature to this correlation are discussed. No distinct conclusions seem to actually be reached by the author.

72. —. 1977. A changing environment: documentation of lizards and plants over a decade. in TRANSACTIONS OF THE SYMPOSIUM ON THE BIOLOGICAL RESOURCES OF THE CHIHUAHUAN DESERT REGION, UNITED STATES AND MEXICO. R. H. Wauer and D. H. Riskind, editors. U. S. Dept. Interior, National Park Service Transactions and Proceedings Series No. 3: 533-555.

The same area is re-visited and the same methods used in 1968 and 1969 as was done in 1966 by this author. Lizard population density estimates are given for each study quadrat. It is suggested that an increase in vegetation density up to a certain optimum for each lizard species will result in an increase in population density for that species; increases above that vegetation optimum will result in a decrease in lizard population density. Cnemidophorus tigris is shown to prefer relatively open areas and is suggested to outcompete at least one other congener (septemvittatus).

73. Dessauer, H. C., W. Fox and F. H. Pough. 1962. Starch-gel electrophoresis of transferins, esterases and other plasma proteins of hybrids between two subspecies of Whiptail lizard (genus Cnemidophorus). COPEIA 1962(4): 767-774.

Twenty protein bands were identified in C. tigris gracilis, C. t. marmoratus, and hybrids between the two; 12 bands were common to both subspecies and 4 were unique to each. F₁ and backcross hybrids were found, indicating that hybrids are fertile. The zone of hybridization in SE Arizona-SW New Mexico appears broader than indicated by Zweifel (1962), although this paper supports that one in other respects; is indeed complementary to it.

74. Douglas, C. L. 1966. Amphibians and reptiles of Mesa Verde Na-

tional Park, Colorado. UNIV. KANSAS PUBL. MUS. NAT. HIST. 15(15): 711-744.

The geology, climate and vegetation of the park are characterized. Cnemidophorus velox is found mostly at lower elevations along the southern halves of mesas and is locally abundant around the park headquarters. Lizards were gravid in June and hatchlings were first seen at the end of August. The behavior of captives is described. Endoparasites of the species are listed.

75. Dixon, J. R. and P. A. Medica. 1966. Summer food of four species of lizards from the vicinity of White Sands, New Mexico. LOS ANGELES CO. MUS. NAT. HIST., CONTRIBUTIONS IN SCIENCE No. 121: 1-6.

Cnemidophorus inornatus forages in the litter beneath vegetation. A graphic representation of food items for this species is given; lepidopteran and coleopteran larvae (41%) and coleopteran adults (12%) are the main prey. Competition with Holbrookia and Sceloporus is avoided by differences in foraging methods and foods eaten.

76. DuBois, E. P. 1943. Osteology of the skull of Cnemidophorus. AMERICAN MIDLAND NATURALIST 30(2): 510-517.

A detailed analysis is presented; species used include gularis and sexlineatus.

77. Duellman, W. E. and C. H. Lowe. 1953. A new lizard of the genus Cnemidophorus from Arizona. CHICAGO ACADEMY OF SCIENCES NATURAL HISTORY MISCELLANEA No. 120: 1-8.

C. sacki xanthonotus (= C. burti xanthonotus) is formally named, described and diagnosed. It is known only from the Puerto Blanco and Ajo Mountains, Pima County, Arizona. It occurs in relictual mesic communities, in the juniper-oak-desert edge ecotone in canyons on west slopes. These canyons have narrow rocky walls well-covered with vegetation, and have intermittent water in their bottoms. The south-facing slope of the type-locality possesses typical plants of the Sonoran Desert; the north-facing slope lacks these and instead possesses Juniperus, Berberis, Ephedra, Agave and grasses.

78. —. and R. G. Zweifel. 1962. A synopsis of the lizards of the sexlineatus group (genus Cnemidophorus). BULLETIN OF THE AMERICAN MUSEUM OF NATURAL HISTORY 123(3): 155-210.

Detailed morphologies and ranges are given for Cnemidophorus bur-ti (all subspecies), C. exsanguis (includes flagellicaudus and sonor-ae), C. gularis, C. inornatus (= inornatus + uniparens), C. perplexus (= neomexicanus), C. sexlineatus and C. velox. The lack of males in exsanguis, perplexus, velox and the western populations of inornatus (= uniparens) is noted.

79. **Echternacht, A. C.** 1967. Ecological relationships of two species of the lizard genus Cnemidophorus in the Santa Rita Mountains of Arizona. AMERICAN MIDLAND NATURALIST 78(2): 448-459.

Data on daily and seasonal activity patterns, food and foraging behavior, intra- and interspecific encounters and reproduction are presented and discussed for C. exsanguis (probably = sonorae) and C. tigris gracilis. The author concludes that present competition between the two is largely potential based on a seeming abundance of termites, a staple food item for both species, despite the fact that the two species occupy almost mutually exclusive habitats on the study area and that varying degrees of difference occur in other ecological factors examined.

80. **Edgren, R. A.** 1955. Possible thermo-regulatory burrowing in the lizard Cnemidophorus sexlineatus. CHICAGO ACADEMY OF SCIENCES NATURAL HISTORY MISCELLANEA No. 141. 2 p.

Individual lizards dig burrows that parallel the sand surface at a depth of 20 mm, and that are approximately 1.5 times as long as the animal itself. They allow the belly of the lizard contact with damp sub-surface sand and the back to remain in contact with the warm dry surface sand. It is suggested that the lizards are behaviorally thermoregulating.

81. **Etheridge, R.** 1958. Pleistocene lizards of the Cragin Quarry fauna of Meade County, Kansas. COPEIA 1958(2): 94-101.

Analysis of the fossil lizard fauna (including Cnemidophorus sex-lineatus), all of which are still extant today, indicates a climate of less extreme winter temperatures and generally more arid conditions than today during the Sangamon interglacial.

82. **Fitch, H. S.** 1958. Natural history of the Six-lined Racerunner (Cnemidophorus sexlineatus). UNIVERSITY OF KANSAS PUBLICATIONS, MUSEUM OF NATURAL HISTORY 11(2): 11-62.

A comprehensive review of the literature on this species is presented. This species belongs to a genus that primarily inhabits deserts or other arid regions. It penetrates far to the north and east of its congeners in the United States, into a region which under original conditions was chiefly deciduous forest. It exists partly in disjunct populations selecting mainly xeroseral habitats such as beaches, sand dunes and the edges of cultivated fields. It seems to require open areas wherever it lives. The species is abundant in the sandy floodplain of the Kansas River. A flood in July of 1951 inundated the area and destroyed the population, which did not recover its former numbers for several years. A population was studied for a period of 9 years on the University of Kansas Natural History Reservation. Deeply eroded gullies in fallow fields, heavily grazed pastures and exposed rock and soil of a limestone quarry provided excellent habitats and lizards were numerous at the beginning of the study. Vegetational succession proceeded as the area was protected and the population declined as open habitats were reduced. The study was terminated when lizards became few in number and no significant new data was being accumulated. Seasonal activity began in April, peaked in June, then abruptly fell off from July through September. Daily activity was bimodal in hot weather. Individual active body temperatures ranged from 38 to 42°C.; lizards will tolerate 5° below and 2° above this range before seeking shelter. Air temperatures were always below active body temperatures. This was the last species of reptile to emerge from hibernation on the study area. An individual male had an observed home range of .31 acres although this figure is probably biased because the habitat was not uniform; female home ranges were slightly smaller. Activity was concentrated in particular parts of individual home ranges. Lizards were observed to make extremely long movements and shift home ranges during drought years, when vegetation decreased and more habitat became suitable. Lizards dig burrows extensively in soil and beneath rocks when they cannot use those abandoned by other animals. Burrows are defended. Vegetation is also used in which to seek temporary refuge. Food habits from other parts of the species range are discussed; it is noted that olfaction plays a major role with lizards frequently digging for prey such as insect larvae. Copulatory behavior is described; mating appears to be aggressive and promiscuous. There is sexual dimorphism in body proportions and color. The sex ratio is 1:1. Gravid females were first recorded late in May and recorded latest in mid-August. Two clutches per year are probably laid; females mature sexually and lay eggs during their first year of life. Clutches range from 1-6 eggs; first-year females average 2.0 eggs/clutch while older females average 4.4. The earliest hatchlings emerge during the first 2 weeks of August and the second clutch hatches during September. Hatchlings average 32-35 mm snout-vent length and weigh about one gram. The most successful of them add 20 mm and come to weigh 1/2 of adult weight during the six weeks before hibernation. Over-winter survivors reach adult size by summer's end, although growth rates slow to 1/2 that of hatchlings. The largest lizard measured, 5 years old, was 84 mm SVL. Tail-break frequency increases as lizards age, but even 1/2 of the largest and oldest group retain original tails. No sexual difference is apparent. The ultimate escape tactic is speed; however, lizards rely initially

heavily on crypsis. Several species of snakes, hawks, the Collared Lizard, skunks, the raccoon and armadillo are predators. Almost all lizards were infected by the chigger Trombicula alfreddugesi. The population near the reservation headquarters varied from 40 to 72 lizards per acre over a 4 year period: combined percentages of first through sixth year individuals in that population were 57, 25.4, 10, 5.4, 1.5 and 0.7. Loss of roughly one-half of the individuals in each age group in the course of a year is indicated.

83. —. 1970. Reproductive cycles in lizards and snakes. UNIV. KANSAS MUS. HIST. MISC. PUBL. No. 52. 247 pp.

This is mostly a review article and presents data on Cnemidophorus exsanguis, C. sexlineatus, C. tessellatus, C. tigris and C. velox. Original data are presented concerning age-size class distributions and reproductive status of a population of C. tigris marmoratus from Reeves County, Texas. Males are larger than females, females may reproduce when one year old, and the smallest reproductive female was 75 mm SVL.

84. Gaffney, F. G. and L. C. Fitzpatrick. 1973. Energetics and lipid cycles in the lizard, Cnemidophorus tigris. COPEIA 1973(3): 446-452.

The lipid cycles in carcass, liver and post-coelomic fat bodies were determined for adults of both sexes of lizards collected near the NE city limits of El Paso, Texas. Fat bodies were used for maintenance during winter dormancy. The timing of reconstitution of lipid reserves during the active season differed between the sexes in correlation with their reproductive roles. Variation in activity between the sexes during the active season is indicated.

85. Gehlbach, F. R. 1965. Herpetology of the Zuni Mountains region, northwestern New Mexico. PROC. U. S. NATL. MUS. 116(3505): 243-332.

The topography, geologic history, climate, vegetation, and recent environmental changes occurring in the region are discussed in detail. Cnemidophorus velox occurs in the region; historical accounts and the nomenclatural history of the species in New Mexico is discussed. Data on morphological variation is discussed; possible males or hybrids with C. inornatus are described. C. velox occurs between 6000 to 8000 feet and is most common at about 6400 feet. It prefers open areas of the Roughlands life belt especially where saltbush-sage associations occur in isolated patches in pinyon-juniper savanna. Notes on reproduction are given.

86. —. 1979. Biomes of the Guadalupe Escarpment: vegetation, lizards, and human impact. in BIOLOGICAL INVESTIGATIONS IN THE GUADALUPE MOUNTAINS NATIONAL PARK, TEXAS. Genoways, H. H. and R. J. Baker, editors. National Park Service Proc. and Trans. Series No. 4: 427-439.

The vegetational basis of biome patterns in the Guadalupe Mountains ecosystem is described. The relationship between biomes and lizard species distribution in both grazed and ungrazed habitats is explored. Cnemidophorus exsanguis is characteristic of the relatively mesic margins between deciduous and evergreen woodlands on canyon slopes at elevations around 5500 ft. C. inornatus is characteristic of xeric shrub desert flats at 4000 ft. C. tessellatus is abundant in the more mesic succulent desert and on canyon slopes at about 4700 ft. C. gularis and C. tigris are scarce; the former occurs in grassland remnants and the latter in arenaceous areas of shrub desert. C. tessellatus is abundant throughout the temporal sequence of revegetation of a pipeline construction scar in the succulent desert biome, whereas it declines in grazed habitats versus protected ones in this biome. There are no differences in C. exsanguis populations between grazed and ungrazed habitats in evergreen woodland. Evidence indicates that C. tigris and C. septemvittatus replace each other from shrub desert through succulent desert transitions in the Big Bend region of Texas, and therefore, by implication, C. tessellatus does not compete successfully with either and is relegated to marginal habitats (i.e. canyons, which can be considered disturbed areas).

87. Germano, D. J. and C. R. Hungerford. 1981. Reptile population changes with manipulation of Sonoran Desert shrub. GREAT BASIN NATURALIST 41(1): 129-138.

Cnemidophorus sonorae and C. tigris gracilis were among the species studied on the Santa Rita Experimental Range in Pima County, Arizona. Desert grasslands in the southwestern United States have been invaded by mesquite during the last 100 years. C. tigris populations were significantly lower in mesquite-free habitats versus undisturbed mesquite and mesquite with clearings. C. sonorae populations were significantly higher in mesquite-free and mesquite with clearings habitats than in undisturbed mesquite. There are indications of differential use of the mesquite with clearings habitats by the two species.

88. Glass, B. P. and H. A. Dundee. 1950. Cnemidophorus tessellatus (Say) in Oklahoma. HERPETOLOGICA 6(2): 30.

Specimens were collected in the Oklahoma panhandle at an elevation of 4400 feet in canyons in pinyon-juniper associations.

89. **Goldberg, S. R. and C. H. Lowe.** 1966. The reproductive cycle of the Western Whiptail lizard (Cnemidophorus tigris) in southern Arizona. JOURNAL OF MORPHOLOGY 118(4): 543-548.

Lizards from near Tucson, Pima County, undergo a seasonal cycle in which gonadal size is minimal in September-October. Male reproductive organs gradually recrudescence during the winter months spent underground. After they emerge from hibernation in March-April the testis, seminiferous epithelial height and tubule diameter gradually increase in size through April and May, reaching maximum size in June-July followed by rapid regression in August. Mating is first observed in the field in May. The ovaries undergo a period of heavy yolk deposition from early April to May, and remain functional until August. A thick circumtesticular subtunic layer of equivalent interstitial material (Leydig cells) is reported and described for the genus.

90. **Gorman, G. C.** 1970. Chromosomes and the systematics of the family Teiidae (Sauria, Reptilia). COPEIA 1970(2): 230-245.

Teiids have undergone an extensive adaptive radiation. There are about 40 living genera with a total of some 175 species. If chromosome data alone were used, one would definitely consider the family to be of South American origin. The fossil record shows that such an interpretation is unwarranted. There was a rich and diverse macroteiid fauna during the Cretaceous in North America with all modern lineages represented. Teiid diversity appears to have dropped drastically in North America following the Cretaceous, for the only positive identifications are of Cnemidophorus-like species. Thus the present distribution of the Teiidae is one of range shift or contraction. It is possible that the loss of climatic equability toward the end of the Cretaceous, postulated to account for dinosaur extinction, eliminated from North America all teiids that were not adapted to xeric conditions. Absence of a Cenozoic land bridge until the Pliocene slowed recolonization of North America by South American teiids. Although Cnemidophorus-like lizards have been in North America from at least the early Miocene, they have not been the source of a major adaptive radiation. This may not be due to lack of time, but to the rigid specialization of Cnemidophorus to an open niche with high insolation.

91. —, **Y. J. Kim and C. E. Taylor.** 1977. Genetic variation in irradiated and control populations of Cnemidophorus tigris (Sauria, Teiidae) from Mercury, Nevada, with a discussion of genetic variability in lizards. THEORETICAL AND APPLIED GENETICS 49(1): 9-14.

A fenced population that had been irradiated for 10 years was studied, as was a fenced non-irradiated and a free-ranging population.

No significant differences in allele frequency were found at 26 allozyme loci examined. This is the most polymorphic and heterozygous of the 21 lizard species so far examined (35%; mainland species only). A general trend is apparent. Fossorial lizards have uniformly low levels of heterozygosity (ca. 1%), territorial "sit and wait" predators are intermediate (ca. 5%), and highly vagile apparently nonterritorial species are most heterozygous (ca. 10%). If this trend is of biological significance, it can be explained by (1) the niche width variation hypothesis which predicts higher variability in populations where individuals are exposed to large-scale environmental heterogeneity (in reality, comparison of "niche widths" among the diverse lizards used in this study is difficult at best, and no data is available), and/or (2) the population size or gene flow variation hypothesis, which predicts that, all other things being equal, vagility would tend to increase the effective population size by reducing inbreeding, which would promote higher levels of genetic variation.

92. Gundy, G. C., C. L. Ralph and G. Z. Wurst. 1975. Parietal eyes in lizards: zoogeographical correlates. *SCIENCE* 190(4215): 671-673.

The parietal eye is important for reproductive synchronization and thermoregulation in lizards. There is a general trend of low-latitude restriction of parietal-eyeless lizards. The Teiidae are parietal-eyeless and centered on the equator where 18 of the 31 genera overlap. The genus *Cnemidophorus* ranges northward to 43° latitude (it is interesting to note that many of the northernmost species are parthenogenetic).

93. Hadley, N. F. and D. C. McCaleb. 1977. Changes in lipid composition of oocytes during vitellogenesis in the parthenogenetic lizard *Cnemidophorus uniparens* (Reptilia, Lacertilia, Teiidae). *JOURNAL OF HERPETOLOGY* 11(4): 411-414.

The amounts and fatty acid composition of the main lipid classes for pre- and post-ovulatory oocytes of lizards from Graham County, Arizona, were determined and discussed in relation to thermal regime, mode of reproduction, and diet.

94. Hamilton, D. W. 1964. The inner ear of lizards. I. Gross structure. *JOURNAL OF MORPHOLOGY* 115(2): 255-272.

Cnemidophorus tessellatus is among the species used in a general account of the variation in gross structure that occurs within and between lizard families. 4 groupings based on this variation are discernable; *C. tessellatus* is somewhat intermediate between the Lacertid and Gekkonid clusters.

95. Hardy, D. F. 1962. Ecology and behavior of the Six-lined Race-runner, Cnemidophorus sexlineatus. U. KANSAS SCI. BULL. 43(1): 3-73.

Laboratory, field and artificial enclosure observations were made on a population inhabiting a sparsely vegetated sand dune habitat in the floodplain of the Kansas River. Thermoregulatory behavior is described. The preferred body temperature is 40-41°C., the thermal activity range is 34-41°C., lizards will not become active until their body temperature is approximately 20°C. There are different thermal thresholds for different behaviors. Daily activity cycles are described, with the hunger drive implicated as the initiating factor. Seemingly stereotyped defecation behavior is described. Peak seasonal activity occurs in May and June; by the beginning of September adults are only occasionally active. This is correlated with an increase in body fat storage and concomitant increase in the daily thermal threshold for activity due to a decrease in the physiological need for food. Egg deposition sites are typically open, sloping, fine-grained sandy areas. The population exhibits 4 distinct egg-laying periods, each representing a different age-size class of females. Females 3 years or older probably lay 2 clutches per year. Clutch size for yearlings is 1-3 eggs and for older females is 3-5 eggs. Incubation averages 50 days. 4 types of shelter (3 of them burrows) and the behavior associated with making and/or using them are described. Both vision and olfaction are used in hunting; associated behaviors are described. There are sexual, size, and seasonal differences in types of prey taken. Food habits are analyzed in detail. Predators and parasites are briefly discussed. Straight-line social hierarchies are established under captive conditions. Color is only functional in threat behavior between aggressive males. Mating behavior is described. Aggressive behavior in nature is thought to achieve population spacing in favorable habitats; less aggressive individuals being displaced to suboptimal habitats.

96. Hardy, L. M. and C. J. Cole. 1981. Parthenogenetic reproduction in lizards: histological evidence. J. MORPHOLOGY 170(2): 215-237.

Serial histological sections of the complete urogenital systems of 9 F₂ specimens belonging to two ontogenetic series of Cnemidophorus exsanguis raised in captivity in isolation from males were examined, as well as that of the F₁ mother of one of these series. No evidence of spermatozoa or testicular tissue was found. Comparative material reveals that the histology of the urogenital tract is similar to that of females of the bisexual species C. sexlineatus and C. tigris. Evidence of 8 specific points useful in the determination of true parthenogenesis (absence of males, morphological variation, ploidy levels, histocompatibility, histology of the reproductive tract, oogenesis, reproduction in captivity, and karyotype inheritance) is reviewed for C. exsanguis. It is concluded that this species is parthenogenetic and that normal reproduction does not involve sex-reversal, self-fertilization,

gynogenesis, hybridogenesis, or spermatozoa in any way whatsoever.

97. **Harris, A. H.** 1965. The origin of the grassland amphibian, reptilian, and mammalian faunas of the San Juan-Chaco River drainage. PH.D. DISSERTATION, UNIVERSITY OF NEW MEXICO. 160 p.

Grassland habitat of the present type was absent during the last major Pleistocene pluvial. Animals associated with it had to invade through habitat corridors to the northwest or from relatively low-lying areas along the Continental Divide to the southeast. Climatic and vegetational changes of the area since the last major pluvial (Wisconsin) are discussed in detail. Cnemidophorus tigris septentrionalis is found along washes and in rocky areas of pinyon-juniper habitats in the study area. C. tigris marmoratus is found in the Rio Grande basin to the east and southeast, and the two subspecies are separated by the Continental Divide. Previous contact was impossible and the former invaded from the north and northwest. Cnemidophorus inornatus is rare in the study area; it occurs in a few localities bordering Gallegos Canyon and at the borders of sagebrush and grassland habitats. Only clinal variation exists between this isolated population and those in the Rio Grande basin, therefore they were probably contiguous at one time. The present population invaded during the post-pluvial period, when the climate was most likely warm and wet rather than warm and dry, and may have been isolated for a maximum of 4000 years.

98. —. and **J. S. Findley.** 1964. Pleistocene-Recent fauna of the Isleta caves, Bernalillo County, New Mexico. AMER. J. SCI. 262: 114-120.

The fauna includes Cnemidophorus perplexus. No age is given for the material, nor is it clear which of the currently recognized species is referred to.

99. **Hayward, C. L., D. E. Beck and W. W. Tanner.** 1958. Zoology of the Upper Colorado River Basin. I. The biotic communities. BRIGHAM YOUNG UNIVERSITY SCIENCE BULLETIN, BIOLOGY SERIES 1(3): 1-74.

Cnemidophorus tigris septentrionalis is common in greasewood, cottonwood, tamarisk and willow floodplain habitats with sandy to clay soils in southeastern Utah. It is common over a wider range from barren desert washes to pinyon-juniper habitats with gravelly to rocky soils at Arches National Monument, where C. velox overlaps slightly with it, extending throughout the elevational range of pinyon-juniper habitat. There are local habitat variations for both species apparent throughout the region. C. velox is restricted to the Colorado Plateau Province; C. tigris septentrionalis occurs in that plus the Uinta Moun-

tains Province.

100. Hendricks, F. 1975. Biogeography, natural history and systematics of Cnemidophorus tigris (Sauria; Teiidae) east of the Continental Divide. PH.D. DISSERTATION, TEXAS A & M UNIVERSITY. 227 p.

Scutellation and various aspects of color pattern are analyzed by univariate and multivariate statistical techniques for populations from the complete geographic extent of the range of this species in the area of interest. A remarkably complete review of the literature on this species is provided. This study confirms the ecological characteristics documented for this species. C. tigris is never found in habitats with dense grass or shrubs, or on inclines exceeding 30°, and rarely on those exceeding 15°. It is also unusual to find C. tigris in areas not dominated by creosote; where it is found elsewhere, the species frequents mesquite hummocks in sandy terrain. Creosote communities occupied are usually on gravelly to rocky well-drained terrain such as alluvial fans. It is never found at elevations exceeding 5000 feet and is fairly uncommon above 4000 feet. The range of C. tigris is consequently somewhat disjunct in the Basin and Range topographic province; maps are provided of both. Three new subspecies are named; diagnoses, descriptions and photographs of the types are provided. One, C. t. reticuloriens, occurs in the Pecos River drainage of New Mexico as well as parts of west Texas and Mexico. C. t. marmoratus occurs in the Rio Grande drainage of New Mexico, the Tularosa Basin and westward to the Continental Divide, as well as into west Texas and parts of adjacent Mexico. These two subspecies belong to the same species cluster. It is believed that the subspecies provide geographically and taxonomically identifiable entities while the species clusters more realistically indicate units of evolution. Glacial and interglacial sequences during Pleistocene time are discussed as the most probable cause for the fractionation and differentiation of C. tigris east of the Continental Divide today. Some quite tentative inferences about predation and population structure are drawn based upon the museum specimens examined for this study. The latter do, however, conform to what has been previously suggested by other workers. There is not a bimodal pattern of emergence of hatchlings as could be inferred from previous field work—that is, hatchlings begin to appear, a single numbers peak is achieved and then emergence falls off.

101. Holland, R. L. 1965. A comparative study of morphology and plasma proteins of the blood in the lizard species Cnemidophorus tesselatus (Say) (Reptilia: Teiidae) from Colorado and New Mexico. M.A. THESIS, UNIVERSITY OF COLORADO. 116 p.

Electrophoresis of plasma and erythrocyte proteins were performed on lizards from 3 populations: near Pueblo, Pueblo Co. and on the Purgatoire River, Las Animas Co., Colorado, and near Caballo Dam, Sierra

Co., New Mexico. The latter population differs significantly in the relative proportions of two of the four major plasma protein groups found in this species. Morphological comparisons are made; color and pattern also differ significantly. Color photographs of specimens are provided. Statistically significant differences are also found in several scale characters. Nomenclature is discussed, and the type locality is restricted to "the junction of the Arkansas River and Fountain Creek", Pueblo Co., Colorado. A 100-mile gap exists at the time of this study between Colorado-Oklahoma and New Mexico-Texas populations; morphological differences are felt to be taxonomically significant. It is suggested that the distribution of C. tessellatus is uniformly riparian, reflecting routes of dispersal. It is further suggested that the current distribution map implies that the species is less widespread than it once was, the range discontinuities reflect withdrawal from previously occupied areas. Current relictual populations, if indeed that is what they are, further imply a measure of ecological/evolutionary age for this parthenospecies (opinion of this reviewer).

C. tessellatus can be found in a variety of microhabitats, but are never far removed from some drainage system, however ephemeral. Low shrubby vegetation and few trees characterize habitats. The species seems to prefer sandy-to-silty soils, and not extremely rocky nor grassy areas. The species is sympatric with C. sexlineatus in Colorado and with C. inornatus and C. tigris in New Mexico. Colorado lizards can be approached within 2-3 feet; they can be followed for extensive periods of time and will approach a lizard noose out of curiosity. New Mexico lizards are extremely wary and cannot be approached any closer than 10 feet. The literature is reviewed and the conclusion reached that, on the basis of morphology, there is no indication that unisexual species are more or less variable than bisexual ones. It is suggested that the different morphological characters reported here represent independent genetic factors and that differences between the 2 areas reflects a pattern induced by natural selection. It is further suggested that northern populations of C. tessellatus are distinct from southern ones and perhaps worthy of subspecific rank, which is not proposed at this time because of the preliminary nature of this work.

102. Holman, J. A. 1979. Herpetofauna of the Nash local fauna (Pleistocene: Aftonian) of Kansas. COPEIA 1979(4): 747-749.

The fauna includes Cnemidophorus sexlineatus, and notes on climatic change from maritime to semiarid are given.

103. Hulse, A. C. 1981. Ecology and reproduction of the parthenogenetic lizard Cnemidophorus uniparens (Teiidae). ANNALS OF THE CARNEGIE MUSEUM 50(14): 353-369.

A population was studied over a period of 2 years from late May through the end of August at a site approximately 2 miles west of the

New Mexico-Arizona border along the Portal Road, Cochise County, Arizona. A pitfall trap grid covering one hectare was established. The site was at an elevation of 1500 m., with sandy soil and a few scattered rocks, dissected by numerous shallow, poorly defined washes. Prosopis and Ephedra were the dominant plants, with Acacia, Flourensia, Gutierrezia and Bouteloua. Plant cover was 15-20%, increasing to 30-35% after summer rains. Heteromyid rodent mounds and burrows were numerous and a major source of shelter. Eight other lizard species were sympatric, none of them congeneric. Daily activity was bimodal; 75% of captures occurred between sunrise and 1130 hours with the remainder occurring between 1730 and 1930 hours. This pattern broke down on cloudy days. Rainfall depressed activity for as much as 24-36 hours after heavy rains (more than 3 cm). Seasonal activity peaked the first year during the second half of June with an average of 17 lizards per day handled, and declined to 3.5 lizards per day handled during the second half of August. Seasonal activity was steady throughout the second year, ranging from an average of 2.5 to 4.5 lizards handled per day. Roadrunners, burrowing owls and loggerhead shrikes were observed to prey successfully on C. uniparens; remains were found in the stomach of Crotaphytus wislizenii. Potential predators are discussed. Tail-break frequency increases in older age classes; the overall percentage is 15.6, which is low compared to C. tigris. This is possibly due to a higher success to attack ratio for C. uniparens predators and differences in life-spans between the two species. Mature females range from 58 to 77 mm in snout-vent length (mean SVL is 65.5 ± 3.9 mm). All lizards are reproductive by early June; reproduction continues through the first half of July, then rapidly drops off and ceases by early August. Clutch size ranges from 1-4 with a mean value of $2.77 \pm .06$. There is a significant positive correlation between clutch size and SVL. Two, possibly three clutches are produced annually; clutch intervals varied from 21 to 28 days. No significant correlation existed between SVL and egg size or egg weight. The total clutch weight/body weight ratio ranged between 9.6-20.0 (mean $14.4 \pm .24$). Forty-seven lizards had home ranges entirely within the study area; home range size was not correlated with either the number of recaptures or SVL. Mean home range size differed highly significantly between the two years. The mean home range size was 815 ± 88 m² (range 120-2386) for the first year and 417 ± 62 m² (range 240-746) for the second based on 39 and 8 lizards, respectively. Normal rainfall preceded the first study season whereas the second was preceded by very heavy precipitation, which greatly increased the production of desert annuals and their invertebrate herbivores. Apparently C. uniparens responded to increased prey availability by reducing the average home range size. No territoriality nor aggressive behavior was observed; lizards forage, seek shelter, and fall into the same pitfall traps without paying the slightest overt attention to each other. Growth rates remained the same over the entire study period; differences in prey availability did not influence the volume of prey consumed. Growth rates were negatively correlated with SVL. A sharp decline in growth rate occurs with the attainment of reproductive maturity. Density estimates of adult lizards for the 2 years were 103 ± 6 and 78 ± 12 per hectare; the total number of lizards marked was 135 and 138 and the number of different individuals recaptured was 98 and 82,

respectively. Hatchlings achieve reproductive maturity the season following birth. Less than 10% of the population consisted of the larger size classes in late May, strongly suggesting annual turnover of the population. Only 12 of the 135 lizards marked during the first year were recaptured the second year and, although some migration and shifting of home ranges occurred, this should have little effect on age-size class proportions of the population.

104. Hunsaker, D., II and C. Johnson. 1959. Internal pigmentation and ultraviolet transmission of the integument in amphibians and reptiles. COPEIA 1959(4): 311-315.

The following species of Cnemidophorus lack internal pigment: grahami (= tesselatus), perplexus (= neomexicanus or inornatus), sacki (= gularis or exsanguis), sexlineatus and tessellatus (= tigris). The significance of this fact in light of their ecological aspects is briefly discussed.

105. Jameson, D. L. and A. G. Flury. 1949. The reptiles and amphibians of the Sierra Vieja range of southwestern Texas. TEXAS JOURNAL OF SCIENCE 1(2): 54-79.

Life belts and vegetation associations of the region are described. Cnemidophorus perplexus (= inornatus) reaches its highest abundance on sandy alluvial fans with scattered areas of small rock in the catclaw-tobosa association. It also occurs in nearby sandy areas of the Plains life belt. Cnemidophorus grahamii (= tesselatus) reaches its peak abundance in the creosotebush-catclaw-blackbrush association adjacent to the mountains. This area is quite rocky with little grass but many desert shrubs under which rodent burrows are common. This species also occurs at rocky mouths of canyons, on rocky canyon bottoms and their associated slopes, and in sandy areas (salt cedar-mesquite and creosotebush associations) of the Rio Grande Basin to the west. Cnemidophorus gularis octolinearis (= exsanguis and gularis) occurred in rocky areas of the mountains and plains in several vegetation associations (the authors were unknowingly dealing with both species here). Cnemidophorus tigris was not found in the study area but occurred in the Rio Grande Basin almost exclusively in the catclaw-creosotebush association.

106. Jones, K. B. 1981. Effects of grazing on lizard abundance and diversity in western Arizona. SOUTHWESTERN NATURALIST 26: 107-115.

Comparisons were made between heavily and lightly-grazed chaparral, desert grassland, mixed riparian scrub, cottonwood-willow and Sonoran desertscrub habitats. The abundance and diversity of lizard spe-

cies were down in all heavily grazed habitats except Sonoran desert-scrub. Cnemidophorus exsanguis (= probably flagellicaudus) and C. velox were totally extirpated in some cases and Cnemidophorus tigris numbers drastically reduced due to the elimination of favorable microhabitats and/or the reduction of food supplies.

107. Jones, R. E., T. Swain, L. J. Guillette, Jr. and K. T. Fitzgerald. 1982. The comparative anatomy of lizard ovaries, with emphasis on the number of germinal beds. J. HERPETOLOGY 16(3): 240-252.

Specimens of Cnemidophorus velox from Colorado and C. inornatus, C. tessellatus, C. tigris and C. uniparens from New Mexico all possessed 2 germinal beds (GB) per ovary. These are compact and located on the dorsal ovarian surface antero-posterior to each other. Each ovary of the above species undergoes 1-3 ovulations (presumably per year) except for C. tigris, which ranges 1-4. Instantaneous fecundity (the number of ovulations from both ovaries at one time) is inversely proportional to rates of follicular atresia in preovulatory ovaries of lizard species with 2 GB/ovary. Temperate species tend to have relatively higher instantaneous fecundities than tropical species, which also tend to have only 1 GB/ovary. All the species of Cnemidophorus examined, however, have relatively low instantaneous fecundities for their GB count and latitudinal position. This would tend to substantiate the fact the Teiidae are by and large a tropical family and that the genus Cnemidophorus has expanded into temperate regions, and also that reproductive strategies may be evolutionarily stable, complex, and inert (this reviewer).

108. Jorgensen, C. D. and W. W. Tanner. 1963. The application of the density probability function to determine the home ranges of Uta stansburiana stansburiana and Cnemidophorus tigris tigris. HERPETOLOGICA 19: 105-115.

Home ranges estimated for male, female, and juvenile C. tigris in Nevada are .18, .10 and .09 acres with the minimum polygon method and .71, 1.28 and .54 acres with the density probability function. Factors influencing the estimation of home ranges are discussed.

109. Kay, F. R., R. Anderson and C. O. McKinney. 1973. Notes on activity patterns of two species of Cnemidophorus (Sauria: Teiidae). HERPETOLOGICA 29(2): 105-107.

Individuals of Cnemidophorus inornatus and C. tigris near Las Cruces, New Mexico, were followed for their entire daily activity period. The former species spent more time behaviorally thermoregulating and foraged more thoroughly over a smaller area than did the latter.

110. Kerfoot, W. C. 1969. Selection of an appropriate index for the study of the variability of lizard and snake body scale counts. *SYSTEMATIC ZOOLOGY* 18(1): 53-62.

Previously published data on several species of Cnemidophorus (exsanguis, flagellicaudus, inornatus, neomexicanus, tesselatus, tigris and uniparens) are taken to show that variation in several scale counts is much greater in bisexual than parthenogenetic species.

111. Knopf, G. N. 1966. Reproductive behavior and ecology of the unisexual lizard, Cnemidophorus tessellatus Say. PH.D. DISSERTATION, UNIVERSITY OF COLORADO. 111 p.

Cnemidophorus tessellatus is most abundant in Colorado in arroyos, gullies, and hillsides adjacent to or along river bottoms. It generally occurs in abundance locally when and where found, although it may be absent from equally suitable habitat only a few miles away. The area of this particular study is a 2.03 acre site located on bluffs above the Huerfano River in Pueblo County, Colorado, 26.2 mi. SE of Pueblo at an elevation of 5000 feet. It is heavily overgrazed with scant vegetation, and with several man-made topographic features. The summers are hot and the winters generally rigorous. Dominant vegetation consists of Chrysothamnus nauseosus, Opuntia polyacantha, O. arborescens, Salsola pestifer and Yucca glauca. Lizards were captured by noosing and drift-fence trapping and permanently marked. Resident lizard behavior varied from fleeing after being noosed once to being noosed 20 or more times with little or no escape reaction upon approach by the nooser. Lizards were seldom trapped more than twice, however, before they "learned" to avoid them. All residents were eventually marked. Lizards were considered hatchlings, juveniles, subadults or adults if they were 39-48, 49-66, 67-80, and greater than 80 mm snout-vent length (SVL), respectively. Data for this study is based primarily on the period 18 May-10 September 1965. 87 lizards (16 juvenile, 17 subadult and 54 adult) were marked between late May and mid-July. 17% were never recaptured; the others were recaptured 1-30 times. 35 hatchlings were captured during the fall. The reproductive cycle is discussed in detail. A single clutch of 1-4 eggs was laid during 1965; larger lizards had larger clutches. Oviducal eggs are retained from 3 days to a week or longer; eggs retained longest require a shorter incubation period. Oviducal eggs were first found 12 June and last found 23 July. Evidence suggests that 2 clutches were produced in 1966; 1964 was one of the driest and 1965 one of the wettest years ever recorded in the Pueblo region. Rapid accumulation of large fat reserves begins after oviposition; most older lizards disappeared by mid-August. There were two peak periods of egg-laying, centered around 20 June and 8 July. The first period involved primarily the oldest and largest members of the population. Adults remain in the underground nests for at least 2

days after oviposition. Nest sites were selected in substrate permitting easy burrowing, frequently on a well-drained slope with sufficient soil moisture to insure successful incubation. These slopes were typically devoid of vegetation and exposed to unrestricted solar radiation at all times of the day. Gravid females intent on nesting behave quite differently from non-nesting individuals and these behavioral differences are readily distinguishable. This behavior is best characterized by extended movements out of the home range, scouting of unfamiliar terrain, intensive chemoreception and extreme wariness. Observations indicate that females compete for and "parasitize" the nest sites of one another. Nest sites are defended prior to and immediately after oviposition. Nest sites are communal and females will return periodically over 3 days to scratch additional debris about the nest. It is suggested that lizards return to nest in the same area from which they hatched. Burrows and burrowing behavior is described. Reproductive success was significantly higher in 1965 than 1964. Incubation time varies from 60 to 74 days; the most important variable the length of retention of oviducal eggs. It is suggested that older females retain eggs longer because they are more adept at selection and preparation of nest sites, implying ontogenetic learning. Nest temperatures fluctuated daily between 20-34°C. The first hatchlings in 1965 appeared during the second week of September, although normally they appear two weeks earlier. They remain adjacent to the nest and use it for an overnight shelter after hatching. Many may use it as a hibernaculum as many are caught in the same spot the next spring. Hatchlings continued to emerge until October 5, leading to different size classes which are maintained throughout adulthood. Reproductive maturity is reached during their 3rd growing season (approximately 22 months). Growth rates decline sharply when subadult size is reached; rates are intimately associated with annual environmental productivity. Hatchlings vary between 39.1 mm and 48.2 mm SVL and 1.4 gm to 2.9 gm. Body temperatures between 34-42.6°C. (mean 39.3°C.) were recorded for active lizards. Spring emergence occurs from mid- to late April when soil temperatures to which lizards are exposed reach at least 15°C., fat reserves become depleted and the hunger drive activated. Adults disappear by mid-August although activity continues through mid-October. Hibernacula are all located on SE-facing slopes completely devoid of vegetation and exposed to full solar radiation. The smallest lizards are the first and the largest last to appear in the spring. Daily activity usually begins between 8 and 10 a.m.; the greatest amount of activity occurs between 10 a.m. and 1 p.m. Subtle shifts in this pattern occur during the active season.

Daily recapture rates average 15-20% of the resident population; a maximum of 34% was recorded on August 2nd. All members of the population are not active each day, even though optimum conditions may prevail. Failure to emerge is attributed primarily to success in obtaining food. Different kinds of burrows are dug and utilized for different purposes; an individual lizard may dig several and use them all over the course of a season. All burrows are exclusive and vigorously defended against intrusion by non-residents. Other types of social interaction do not occur. Home ranges are maintained, but are not mutually exclusive and overlap broadly. Sizes for three were .16, .21 and

.25 acres. Migration, except during the nesting season, is minimal; immigration and emigration are negligible. Adults move the least, subadults the most. A population density of 40/acre on the study site was measured during July, with a density of 10/acre in less favorable habitat surrounding it. The population consisted of 19.5% juveniles, 19.5% subadults (2 years old), 34.5% intermediate adults (3 years) and 26.4% old adults (4 years or more). Annual replacement is probably less than 20%. Masticophis flagellum is a constant and troublesome predator; other potential predators include the snakes Pituophis, Hypsiglena, Crotalus viridis, Thamnophis cyrtopsis, the lizard Crotaphytus collaris (rare on the study site), and roadrunners. Of the 35 hatchlings marked in 1965, only 1/2 were recaptured in 1966.

112. Knowlton, G. F. 1934. Lizards as a factor in the control of range insects. JOURNAL OF ECONOMIC ENTOMOLOGY 27(5): 998-1004.

A list of stomach contents in 219 stomachs of Cnemidophorus tigris tigris is given. Almost all insects eaten were injurious to range plants. Orthoptera, Isoptera, Lepidoptera, Diptera and Homoptera were present in greatest frequency; many were larvae or pupae.

113. Legler, J. M. and L. J. Sullivan. 1979. The application of stomach-flushing to lizards and anurans. HERPETOLOGICA 35(2): 107-110.

Cnemidophorus tigris was one of the species used.

114. Leuck, B. E. 1980. Life with and without sex: comparative behavior of three species of whiptail lizards (Cnemidophorus: Teiidae). PH.D. DISSERTATION, UNIVERSITY OF OKLAHOMA. 110 p.

Groups of five conspecific lizards of Cnemidophorus neomexicanus and C. tessellatus (parthenogenetic) and C. sexlineatus (bisexual) were observed in identical outdoor enclosures to determine whether the parthenogens acted more nepotistically towards each other than did the bisexuals as predicted by kin selection theory. Aggressive interactions, competition over food items and fighting were less common in parthenogens than bisexuals, indicating that the genetic relatedness of the former may affect behavioral differences. Genetic unity may also lead to cooperative space use by parthenogenetic lizards, while bisexual whiptails, which are less related to each other, may compete for limited spatial features. Groups of conspecific parthenogens used a significantly greater number of sites for digging burrows than did the more site-specific bisexuals. Neither type maintained territories nor defended objects to the exclusion of conspecifics, and both shared objects under which they burrowed. Parthenogens shared actual burrows 9 times, while this occurred only once among bisexuals. As the number of lizards

above ground increased in each enclosure, aggression levels increased significantly in C. sexlineatus groups containing males. Above ground activity in all species groups peaked in late morning to early afternoon. Nepotistic behavior was never observed among parthenogenetic lizards for several possible reasons. First, members of parthenogenetic populations may not be genetically identical due to independent origin of clones, mutation and/or recombination. Second, because these species are hybrids between two or three bisexual species, they may contain gene combinations that result in competitive rather than cooperative behavior. Third, whiptail species do not defend resources, so opportunities for sharing or sacrificing resources are low (from abstract).

115. —. 1982. Comparative burrow use and activity patterns of parthenogenetic and bisexual whiptail lizards (Cnemidophorus: Teiidae). COPEIA 1982(2): 416-424.

A portion of the preceding study. C. sexlineatus and diploid C. tessellatus used were collected at Conchas Lake State Park, San Miguel Co., New Mexico, triploid C. tessellatus from near Florence, Fremont Co., Colorado, and C. neomexicanus from Albuquerque, Bernalillo Co., New Mexico. Behavior for groups of conspecifics was quantified in outdoor enclosures. Burrows could be dug under 6 objects in an enclosure, along the walls or in open sand. Objects were not equally utilized by any group except female C. sexlineatus. C. tessellatus constructed burrows in open sand more frequently than other groups; all the partheno-species used burrows significantly more than the bisexual groups. 59% of all unisexual lizards observed burrowing used 3-6 sites whereas only 4% of all bisexual lizards seen used more than 2. The lack of site-specificity in the parthenogens is related not only to their genetic similarity to conspecifics but also to their propensity for disturbed habitats where environmental fluctuations are constantly destroying burrows. 20% of all C. tessellatus burrowed in open sand, whereas only 6% of the C. neomexicanus and 13% of all C. sexlineatus did. Of the 9 instances of burrow sharing between parthenogens, 8 occurred in C. tessellatus groups (4 2N and 4 3N). Burrow sharing is attributed to tolerance rather than cooperation. Burrow sites were not defended nor were particular objects monopolized or controlled by high-ranking lizards of any species group. No differences between bisexuals and parthenogens were detected in activity parameters measured. C. neomexicanus was more aggressive than C. tessellatus, but aggression was highest in groups containing male C. sexlineatus. It is concluded that cooperation does not occur between parthenogens, but tolerance for conspecifics is higher than that of bisexuals. The greater incidence of burrow sharing between parthenogens (8 instances in 75 lizards observed versus 1 in 75) is presented as support for kin selection theory. No other variable measured (time of activity, habitat use, defence of resources or aggressive behavior) differed between the species in relation to their reproductive mode.

116. —, E. E. Leuck, II and R. T. B. Sherwood. 1981. A new population of New Mexico Whiptail lizards, Cnemidophorus neomexicanus (Teiidae). SOUTHWESTERN NATURALIST 26(1): 72-74.

The population exists in the vicinity of Conchas Lake, San Miguel County, New Mexico. The habitat is described and morphological comparisons made with other populations of the species. It is concluded that this population is the result of man-made introductions.

117. Lewis, T. H. 1950. The herpetofauna of the Tularosa Basin and Organ Mountains of New Mexico with notes on some ecological features of the Chihuahuan Desert. HERPETOLOGICA 6(1): 1-10.

A belt transect from the mountain crests to the valley floor was censused (T22-23S and R4-5E). The vegetation, soils and topography are described. Cnemidophorus perplexus (probably = neomexicanus), C. tessellatus and C. tigris were collected and discussed.

118. —. 1951. Dark coloration in the reptiles of the malpais of the Mexican border. COPEIA 1951(4): 311-312.

Cnemidophorus tigris at Afton and Kilbourne Hole, Dona Ana County, New Mexico, confine themselves generally to the neutral colored islands of sand and mesquite bush desert scattered through the lava fields. Lizards foraging on the lava retreat to these when disturbed.

119. Little, E. L., Jr. and J. G. Keller. 1937. Amphibians and reptiles of the Jornada Experimental Range, New Mexico. COPEIA 1937(4): 216-222.

A description of the range (vegetation, rainfall) and a brief summary of earlier herpetological surveys done in New Mexico are given. Cnemidophorus perplexus (= inornatus) and C. tessellatus tessellatus (= C. tigris marmoratus) were collected and briefly discussed.

120. Lowe, C. H., Jr. 1955a. A new species of whiptailed lizard (genus Cnemidophorus) from the Colorado Plateau of Arizona, New Mexico, Colorado, and Utah. BREVIORA 47: 1-7.

The name Cnemidophorus velox is resurrected for this lizard. The taxonomic history of this species and of others confused with it (i.e. exsanguis, inornatus) is discussed. A diagnosis is given. This species typically occurs in woodland and coniferous forest. The type locality

is restricted to Oraibi, Navajo County, Arizona; a cotype was collected at Pueblo Bonito, San Juan County, New Mexico.

121. —. 1955b. The occurrence of the lizard Cnemidophorus sexlineatus in New Mexico. COPEIA 1955(1): 61-62.

A very brief note on the first known specimens from the state.

122. —. 1956. A new species and a new subspecies of whiptailed lizards (genus Cnemidophorus) of the inland southwest. BULLETIN OF THE CHICAGO ACADEMY OF SCIENCES 10(9): 137-150.

Cnemidophorus sacki exsanguis (= C. exsanguis) and Cnemidophorus stictogrammus (= C. burti stictogrammus) are formally named, and a diagnosis and description are given for both. Morphological comparisons between the two are made and variation discussed. Both are characterized ecologically. The type locality for the former is Socorro, Socorro Co., New Mexico. It is a riparian (sub)species that extends upward into the lower part of the Yellow Pine Forest to an elevation between 6000 and 7000 feet.

123. —. 1966. The Prairie Lined Racerunner. JOURNAL OF THE ARIZONA ACADEMY OF SCIENCES 4: 44-45.

Cnemidophorus sexlineatus viridis is formally named. A diagnosis, description and distribution for the subspecies are given. The type locality is 7.6 mi. south of Tucumcari along St. Rd. 18, Quay County, NM.

124. —. and S. R. Goldberg. 1966. Variation in the circumtesticular Leydig cell tunic of Teiid lizards (Cnemidophorus and Ameiva). JOURNAL OF MORPHOLOGY 119(3): 277-282.

Cell band widths are given for Cnemidophorus inornatus arizonae (1.2), C. sexlineatus viridis (2.5), C. tigris (6.7), C. gularis gularis (6.9) and C. burti (12.5). A positive correlation exists between the number of cells in a lizard and its body size and age. There is seasonal variation in storage and depletion of intracellular "secretory granules". The possession of this structure by Teiids is apparently unique among vertebrates.

125. —. and —. 1970. Reproduction in the Little Striped Whiptail. JOURNAL OF THE ARIZONA ACADEMY OF SCIENCES 6(2): 162-164.

Seasonal activity and gonadal cycles are described for Cnemidophorus inornatus arizonae from Cochise County, Arizona.

126. —, and J. W. Wright. 1964. Species of the Cnemidophorus exsanguis subgroup of whiptail lizards. J. ARIZ. ACAD. SCI. 3: 78-80.

Cnemidophorus flagellicaudus and C. sonorae are formally named, described and differentiated from C. exsanguis. Ecological and geographic distributions are given for all three species, and variation where two or more of them occur sympatrically is discussed.

127. —, and —. 1966. Evolution of parthenogenetic species of Cnemidophorus, whiptail lizards, in western North America. JOURNAL OF THE ARIZONA ACADEMY OF SCIENCES 4(2): 81-87.

A karyotypic classification is given for the genus. The partheno-species Cnemidophorus neomexicanus is thought to have originated from hybridization between the sexual species C. inornatus and C. tigris, based on karyotypic evidence. The triploid parthenospecies C. uniparens possesses two inornatus-like chromosome complements and one attributed to the sexual species C. gularis. A hypothesis is presented for the evolution of triploid parthenogenetic species. It is suggested that C. neomexicanus is a very recent species, partly because C. tigris today occupies successfully and abundantly the most recently evolved major habitat (desert) in the West, and has recently produced within this environment an array of ecotypes and subspecies in all its major subdivisions. The type specimen of Cnemidophorus perplexus is thought to be a triploid individual from a cross between C. neomexicanus and C. inornatus, and specimens referable to the former indicative of an unsuccessful parthenogenetic event in this genus (see Wright & Lowe, 1967b).

128. —, —, C. J. Cole and R. L. Bezy. 1970a. Natural hybridization between the Teiid lizards Cnemidophorus sonorae (parthenogenetic) and Cnemidophorus tigris (bisexual). SYSTEMATIC ZOOLOGY 19(2): 114-127.

Two hybrid individuals from the Santa Rita Experimental Range in Pima County, Arizona, and their parental species are morphologically and karyotypically described. The hybrids possess 3 genomes from C. sonorae and one from C. tigris. The hybrid habitat is desert-grassland (mesquite type), elevation 3750 ft. C. tigris is by far the most abundant species; C. sonorae and C. uniparens occur in much fewer numbers and are largely restricted to riparian and open (non-mesquite) grassland habitats. The appearance of desert-grassland habitats during the present century due to environmental changes and the contribution of these changes to hybridization in this genus are discussed. The ecologic trans-

formation discussed has clearly favored desert species. The very real potential for the future evolution of polyploid bisexual species of Cnemidophorus as revealed by the characteristics of the allotetraploids reported here is discussed. It is suggested that males reported previously in parthenogenetic species of this genus are due to hybridization events and not to relictual bisexuality.

129. —, —, —. and —. 1970b. Chromosomes and evolution of the species groups of Cnemidophorus (Reptilia, Teiidae). SYSTEMATIC ZOOLOGY 19(2): 128-141.

31 species are divided into 5 species groups based on chromosome data. The sexlineatus group contains the species burti, exsanguis, flagellicaudus, gularis, inornatus, sexlineatus, sonorae, uniparens and velox; the tigris group contains only tigris, and the tesselatus group contains that species and neomexicanus. The karyotype of the deppiei species group appears to be the most primitive among the extant species groups of the genus, and the karyotypes of the other species groups are readily derived from it primarily by means of Robertsonian centric fusions and unequal pericentric inversions. The phylogeny of the genus based on this data is consistent with the overall ecologic and biogeographic distribution of the species. The karyotypically more primitive forms occur in older, more tropical habitats and the karyotypically more derived forms occur in the North American desert.

130. —, —, and K. S. Norris. 1966. Analysis of the herpetofauna of Baja California, Mexico: IV. The Baja California Striped Whiptail, Cnemidophorus labialis, with key to the striped-unspotted whiptails of the southwest. J. OF THE ARIZONA ACADEMY OF SCIENCES 4(2): 121-127.

Cnemidophorus inornatus, C. sexlineatus, C. uniparens and C. velox are treated in the key. The relationship of C. labialis to C. inornatus is discussed.

131. —, and R. G. Zweifel. 1952. A new species of whiptailed lizard (genus Cnemidophorus) from New Mexico. BULLETIN OF THE CHICAGO ACADEMY OF SCIENCES 9(13): 229-247.

Cnemidophorus neomexicanus is formally named, and a description and diagnosis are given. The type locality is the McDonald Ranch HQ, 4800 ft., 8.7 miles west and 22.8 miles south of the New Bingham Post Office, Socorro County, New Mexico. Variation and ontogenetic change in the species is discussed, and the distribution as then known is given. Ecological comparisons with other species of Cnemidophorus are made. This species and C. inornatus are common on and around playas. C. tigris is common at the type locality in yucca-grassland bordering

the playa. C. tessellatus is marginal in its existence at the type locality, being common to higher zones (and different edaphic conditions) but not those as cool and mesic as favored by C. exsanguis. C. tessellatus occurs to the apparent complete exclusion of C. tigris in an area of yucca-grassland and Larrea-grassland" about 10 miles north of the type locality.

132. Lucchino, R. V. 1973a. Biochemical comparison of two sibling species: Cnemidophorus exsanguis and Cnemidophorus sonorae (Sauria: Teiidae). JOURNAL OF HERPETOLOGY 7(4): 379-380.

Combined samples of C. exsanguis from Bernalillo and Catron Counties, New Mexico, were compared to samples of C. sonorae from Cochise County, Arizona. 6 proteins representing at least 9 gene loci were examined; the separate populations of the two forms differ in at least two of them. No intraspecific variation was found.

133. —. 1973b. Genic heterozygosity in bisexual and unisexual lizards of the genus Cnemidophorus. PH.D. DISS., UNIV. OF NEW MEXICO. 93 p.

Protein patterns are given for Cnemidophorus inornatus, C. neomexicanus, C. tessellatus, C. tigris and C. uniparens. Variations in patterns are discussed. There are interpopulational differences in C. tigris marmoratus in New Mexico. The same kinds of differences exist in C. tessellatus; sibling species within this taxon are suggested. 25% of bisexual gene loci examined are polymorphic whereas only 10% (6.6% if C. tessellatus is omitted) of unisexual gene loci are. C. neomexicanus may be a very young species. No variation was found in C. tessellatus class E lizards examined. It is suggested that variation in protein patterns of C. inornatus and C. uniparens supports neutral selection, and that the remainder of the data presented here equivocates between neutral and natural selection (this entire work is poorly done in the opinion of the author of this review).

134. MacLean, W. P. 1974. Feeding and locomotor mechanisms of Teiid lizards: functional morphology and evolution. PAPEIS AVULSOS DE ZOOLOGIA SAO PAULO 27(15): 179-213.

Several species of Cnemidophorus (burti stictogrammus, inornatus, neomexicanus, sexlineatus, tessellatus and tigris) were used. Details of skull morphology, tongue and hyoid musculature, and trunk and limb skeletons are given. New subfamilial arrangements are made. The Teiinae, which includes the genus Cnemidophorus, are large in size and actively escape from predators. They are inertial feeders specialized to rapidly ingest relatively small prey.

135. McCoy, C. J., Jr. 1965. Life history and ecology of Cnemidophorus tigris septentrionalis. PH.D. DISS., UNIV. OF COLORADO. 178 p.

11 populations in a variety of ecological situations below 6000 feet in the valleys of major river systems were studied for 3 seasons in Colorado. This distribution results from recent dispersal up desert corridors. Pure stands of Sarcobatus vermiculatus and pinyon-juniper woodlands on sandy soils are preferred. Morphology is discussed. The most important food items are Lepidopteran larvae, Coleoptera, Orthopteran nymphs, and spiders. Seasonal shifts in food items are the result of changing acceptability and availability of prey and a rigid prey size selection standard. Adults and subadults utilize significantly different food sources. Evidence of predation is lacking although 15% of adults have had broken tails. Soil temperatures exert the basic control on daily activity cycles. Seasonal activity lasts from early May until late September. Individual adult males are active for only 60-75 days; females are active for 75-90 days. Lizards spend the inactive season in self-constructed burrows. The reproductive cycle is discussed. Hatchlings average a snout-vent length of 37 mm. Adult size is reached in 13-14 months and reproductive maturity in 22 months. One clutch per year is laid averaging 3.4 eggs (ranging from 2.9-3.9 and increasing with age). Home ranges are not defended and overlap broadly; that of males is larger than that of females. Both size and complexity of home range increase with a lizard's age. A density of 7 lizards/acre was measured for one study area. The sex ratio is 60:40 in favor of males; this is attributed to increased mortality of females during their longer active season. Individual ecological life expectancy is 6 seasons, 4 as a reproductive. The annual replacement in the breeding population is less than 20% (from abstract).

136. —. 1968. Food selection and age-class competition in Cnemidophorus tigris. JOURNAL OF HERPETOLOGY 1(1-4): 118.

Seasonal changes in the proportions of food items eaten are reported for C. t. septentrionalis in western Colorado. Adult and subadult lizards depend on significantly different parts of the local prey population. The reduction of food competition permits a large annual class of sub-adults to exist, and provides for a more resilient population response to short-term environmental fluctuations.

137. —. 1974. Communal hibernation of the lizard Cnemidophorus tigris (Teiidae) in Colorado. SOUTHWESTERN NATURALIST 19(2): 218.

3 lizards were found together in a burrow, which is described. This phenomenon is suggested to be a response to extreme winter temp-

eratures.

138. —. and G. A. Hoddenbach. 1966. Geographic variation in ovarian cycles and clutch size in Cnemidophorus tigris (Teiidae). SCIENCE 154(3757): 1671-1672.

The activity seasons for C. t. septentrionalis in Colorado and C. t. marmoratus in Texas were determined. Older lizards in both areas lay larger clutches. Colorado lizards lay one clutch per year averaging 3.4 eggs; Texas lizards average 2 clutches per year each averaging 2.2 eggs.

139. McKenna, T. M. and G. C. Packard. 1975. Rates of heat exchange in the lizards Cnemidophorus sexlineatus and Sceloporus undulatus. COPEIA 1975(1): 162-169.

Lizards from Colorado were heated and subsequently cooled through a range of 21-39°C. They heated up faster than they cooled off. This differential was not due to endogenous heat production at any temperature and is attributed to changes in thermal conductivity mediated by the cardiovascular system. This indicates a capacity for these small lizards (average weight 6 gm) to control their rates of heat exchange with the environment.

140. McKinney, C. O., F. R. Kay and R. A. Anderson. 1973. A new all-female species of the genus Cnemidophorus. HERPETOLOGICA 29: 361-366.

Cnemidophorus laredoensis from Webb County, Texas, is named, described, and compared morphologically and biochemically. It is diploid and its parental species are most likely C. gularis and C. sexlineatus.

141. Maslin, T. P. 1950. Herpetological notes and records from Colorado. HERPETOLOGICA 6(3): 89-95.

Distributional notes are given for Cnemidophorus tessellatus and C. perplexus (= probably velox), as well as morphological descriptions of young and adults of both species. The placement of Cnemidophorus grahamii Baird and Girard in the synonymy of C. tessellatus (Say) is confirmed. Cnemidophorus gularis octolineatus is placed in the synonymy of C. perplexus.

142. —. 1962. All-female species of the lizard genus Cnemidophorus (Teiidae). SCIENCE 135(3499): 212-213.

This is the first conclusive report of parthenogenesis in this genus. Museum specimens of C. exsanguis, C. neomexicanus, C. tessellatus, C. uniparens and C. velox collected at all times of the year were examined, and all were found to be females. A genetic basis for this phenomenon is suggested rather than differential utilization of habitats and/or activity periods by males.

143. —. 1966. The sex of hatchlings of five apparently unisexual species of whiptail lizards (Cnemidophorus, Teiidae). AMERICAN MIDLAND NATURALIST 76: 369-378.

The ecological and genetic hypotheses regarding parthenogenesis are reviewed as they might apply to the genus Cnemidophorus. Eggs obtained from wild-caught individuals of 4 presumed parthenogenetic species (exsanguis, perplexus (= neomexicanus), tesselatus and velox) produced only female progeny. Hatching success was low; this is postulated as a reason for the spotty distribution and/or local extinction of populations of these species, but is also at least partly due to laboratory procedures. The habitat exclusion and inequality of numbers of bisexual and unisexual Cnemidophorus where they are geographically sympatric (i. e. sexlineatus and tesselatus in Colorado) is briefly discussed.

144. —. 1967. Skin grafting in the bisexual Teiid lizard Cnemidophorus sexlineatus and in the unisexual C. tessellatus. JOURNAL OF EXPERIMENTAL ZOOLOGY 166(1): 137-149.

Pattern classes of C. tessellatus from Colorado (A, B, and C) and New Mexico (E) were studied, as well as C. neomexicanus from New Mexico and C. sexlineatus viridis and C. tigris septentrionalis from Colorado. Procedures were tested and rejection criteria were established. Homografts between individuals of isolated populations of C. tessellatus are accepted. This species will reject skin grafts from other species of Cnemidophorus. Pattern classes A and B from east of the Rocky Mountains are histocompatible. One individual from pattern class C rejects grafts from class A and B individuals but can successfully donate to them as well as to individuals of class E from northern New Mexico west of the Continental Divide. Class E individuals can successfully donate to the other three classes. Northern class E individuals reject grafts from classes A and B but accepts class C grafts. These skin graft reactions are correlated with the triploid nature of pattern classes A and B and the diploid nature of C and E. The lack of uniform results and the small samples used does not preclude the possibility of incompatible clones within the geographic areas of individual pattern classes.

145. —. 1968. Taxonomic problems in parthenogenetic vertebrates.

The systematic treatment of uniparental species is reviewed. They are and have been recognized using all criteria that have been applied to bisexual species (i.e. morphology, ethology, occupying a distinct niche, having geographic range), with genetic isolation of the species gene pool implicit. This logically implies, however, that interbreeding must be able to take place between individuals of that species, therefore the classic species definition is inadequate for parthenoforms. The author favors the Simpsonian evolutionary species concept. Clonal variability within a unisexual "species" is pointed out, and it is suggested that formally naming such makes no more sense than naming genetic strains of laboratory animals or variants in a stable polymorphic species. It is possible that repeated hybridizations between the same two species could give rise to genetically different clones (this, in fact, has almost certainly occurred in Cnemidophorus tessellatus) and that these new gene combinations could be operated on effectively by natural selection without being swamped out, but the author does not favor giving each such clone specific rank. Hybrid parthenoforms will not be genetically adapted to any one habitat or niche and can readily make use of niches, often man-made, that are not occupied, or that are not too firmly occupied. They cannot compete where another species is well entrenched and an integral part of a stable community.

146. —. 1971a. Conclusive evidence of parthenogenesis in three species of Cnemidophorus (Teiidae). COPEIA 1971(1): 156-158.

Cnemidophorus neomexicanus, C. tessellatus and C. uniparens were raised through 3 generations in the laboratory. All offspring were produced without benefit of paternal fertilization and all were female.

147. —. 1971b. Parthenogenesis in reptiles. AMERICAN ZOOLOGIST 11(2): 361-380.

A general review article, discussing origins, evolution, genetics of parthenogenesis, nomenclatural and systematic problems, and the occurrence of males. 8 male Cnemidophorus tessellatus had been collected from the vicinity of Presidio, Texas, as of June 1968. The chief advantage to parthenogenesis is the ease of colonization of new habitats. Evidence exists that an optimum density threshold must be passed before a parthenogenetic population becomes stable; this implies that single individuals do not found populations. Heavy collecting and commercial alteration of habitat wiped out populations of C. exsanguis and C. tessellatus, respectively. Hybrid parthenospecies are in a sense preadapted because they are not fixed genetically by past selection, although further selection is still possible. Their richer genetic complexion could compensate for their reproductive rigidity. Those that reproduce

through premeiotic endoduplication can acquire and maintain large numbers of chromosomal aberrations and mutations. The importance of synaptic junctions during meiosis no longer exists and each chromosome can evolve independently. New genomes can be acquired through hybridization without disrupting the reproductive process. Access to increased quantities of DNA can be acquired which can be utilized in evolving new mutations without disrupting the balanced array of genes which successfully maintain the species.

148. —. 1972. Discussion: the role of environment in the evolution of life history differences within and between lizard species. OCCASIONAL PAPERS, UNIVERSITY OF ARKANSAS MUSEUM, No. 4: 93-95.

Cnemidophorus tessellatus is so efficient in food gathering that just one or two hours of foraging are sufficient for as much as two days. Such efficiency could be an important parameter in a species that must produce several clutches of eggs a season and continue to grow or maintain itself.

149. —, R. G. Beidleman and C. H. Lowe, Jr. 1958. The status of the lizard Cnemidophorus perplexus Baird & Girard (Teiidae). PROCEEDINGS OF THE UNITED STATES NATIONAL MUSEUM 108(3406): 331-345.

A detailed and very interesting investigation into the following questions; a) what specimen constitutes the type, b) where is the type locality, c) with what species in this area may the name be associated? The type specimen is USNM 3060, collected by William Gambel during the last week of July, 1841, in the Rio Grande valley southwest of Santa Fe in Sandoval County. A description of the type is given and it is compared with the species known from the area. It is concluded that the specimen represents that known as C. neomexicanus, which is thus synonymized (NOTE: C. neomexicanus does not now = C. perplexus; see Wright and Lowe, 1967b).

150. Mecham, J. S. 1979. The biogeographical relationships of the amphibians and reptiles of the Guadalupe Mountains. in BIOLOGICAL INVESTIGATIONS IN THE GUADALUPE MOUNTAINS NATIONAL PARK, TEXAS. Genoways, H. H. and R. J. Baker, editors. National Park Service Proceedings and Transactions Series No. 4: 169-179.

Cnemidophorus gularis, C. inornatus and C. tigris are all essentially confined to the desert plains below 4500 feet; the latter species has apparently been collected in the immediate vicinity only from mesquite dunes bordering the salt flats to the southwest. C. exsanguis and C. tessellatus are common in more open roughland habitats to approximately 6000 ft.

151. Medica, P. A. 1967. Food habits, habitat preference, reproduction and diurnal activity in 4 sympatric species of whiptail lizards (Cnemidophorus) in south-central New Mexico. BULLETIN OF THE SOUTHERN CALIFORNIA ACADEMY OF SCIENCES 66(4): 251-276.

Three study areas near the Rio Grande are described and their vegetation characterized. Rainfall during one study year (1964) was the lowest ever recorded at the NMSU weather station; rainfall during the second study year (1965) was normal. Cnemidophorus exsanguis and C. inornatus preferred mesic habitats of saltgrass-tumbleweed and saltcedar-saltbush during 1964; C. neomexicanus and C. tigris preferred more xeric creosote-mesquite association habitats. All species became more intimately associated throughout the study habitats during 1965. All species except exsanguis expanded into habitats not occupied in 1964 and all species except tigris increased population density. Graphic representations of food items for all 4 species are presented. Lepidopterans were the most important food item for all 4 species. Interspecific competition is reduced by differential prey-size preferences and habitat preferences; neomexicanus and tigris are probably in some competition because of similarities in both parameters. Changes in food items consumed occurred from 1964 to 1965; consumption of lepidopterans increased, that of ants decreased and that of termites ceased. C. exsanguis laid only one clutch of eggs per year, the others laid two. C. exsanguis laid the most eggs and was the most numerous of the 4 species. More males of the sexual species were present in the population during July than females. Seasonal activity is described, with immatures of all 4 species appearing first in the spring, adults appearing by late May and disappearing by late August, and hatchlings remaining active through September. No interspecific differences in preferred temperatures were found. Seasonal daily activity is described; lizards emerged when soil temperatures were 26-30°C. and disappeared when the soil temperature reached 50°C. It is suggested that competition between neomexicanus and tigris is the likely reason the former is distributionally limited primarily to the Rio Grande valley.

152. —, G. A. Hoddenbach and J. R. Lannom, Jr. 1971. Lizard sampling techniques. ROCK VALLEY MISC. PUBL. No. 1. 55 p.

Basic techniques used in studying lizard population demographics, including assessing population sizes and reproductive cycles, are presented and discussed. The unreliability of density estimates currently based on walking transects is discussed. Cnemidophorus tigris is one species illustrated.

153. Milstead, W. W. 1953. Ecological distribution of the lizards of

the La Mota Mountain region of Trans-Pecos Texas. TEXAS JOURNAL OF SCIENCE 5(4): 403-415.

The geomorphology, topography, vegetation and climate of the area are described in detail. 8 vegetational-topographical associations are described, and the lizard species found in each are listed. Cnemidophorus inornatus is found only in the ocotillo-catchlaw association of mesa tops. C. tessellatus is the most widespread species, occurring in 7 associations. The confusion over the type-locality of this species is detailed, and is herein restricted to "Pueblo, Pueblo County, Colorado: collected on the morning of 19 July 1820 near the mouth of Castle Rock Creek (probably = Fountain Creek)." C. tigris marmoratus was collected from 4 association. It was more numerous than C. tessellatus in two of them and less numerous in the other two; about equal numbers of the two species were collected in the 4 associations. Biogeographical relationships are discussed.

154. —. 1957a. Observations on the natural history of 4 species of whiptail lizard, Cnemidophorus (Sauria, Teiidae), in Trans-Pecos Texas. SOUTHWESTERN NATURALIST 2(2-3): 105-121.

Detailed observations on the ecological attributes of Cnemidophorus perplexus (= inornatus), C. sacki (probably = gularis), C. tessellatus and C. tigris marmoratus were made in Brewster and Presidio Counties, Texas. Foraging activities and behavioral differences are described. Behavioral thermoregulation and microhabitat selection are discussed in relation to seasonal ambient soil temperatures. Data on home ranges are presented for C. t. marmoratus. One lizard recaptured 17 times had a home range calculated as .53 acres, but this study only encompassed 14 days, so this value may be imprecise. Lizards were not territorial. Reproductive data is interpreted as indicating a single long breeding season; however, the data also suggests that two clutches per female are laid. The separation of adult and juvenile activity patterns late in the year is discussed.

155. —. 1957b. Some aspects of competition in natural populations of whiptail lizards (genus Cnemidophorus). TEXAS JOURNAL OF SCIENCE 9(4): 410-447.

Several species (exsanguis, gularis, inornatus, tessellatus and tigris) were studied at 3 locations in Trans-Pecos Texas. Field time of the investigator was limited. There appears to be distinct ecological separation between all the species, with very little overlap. One species always predominates when two occur together in the same vegetation association, while the other is reduced in numbers. The least amount of ecological separation appears to be between tigris and tessellatus; they are the only two species that occur together in the same association. Populations of all the species are disjunct through-

out the area; interspecific competition is implicated. Plains habitats are preferred by gularis, inornatus and tigris whereas roughland habitats are preferred by exsanguis and tesselatus. Competition between a species in its preferred habitat and one "invading" it (i.e. not in the invader's preferred habitat) almost always occurred between a sexual and a parthenogenetic species. Intraspecific aggression occurred, particularly in inornatus, but not on a predictable basis. Interspecific aggression did not occur, although lizards did meet and notice one another. Territoriality was not evident. It was found that a meeting between two lizards is not a common occurrence even where lizards are numerous. Species and geographic differences existed in prey consumption; in general, Isoptera > Orthoptera > Coleoptera > Lepidoptera > Hemiptera. Termites are by far the most important food item and may be regarded as the staple food for all species; indeed, the genus is adapted morphologically for this. Competition for the staple food source is the only obvious explanation for the ecological separation of the species, because size differences and alternate food differences do not allow them to coexist. Differences in foraging activities reflect temperament; inornatus is not easily excited whereas tigris is very nervous and wary, the other species falling between these extremes. Lizards are active only when soil temperatures range between 30-50°C. No interspecific differences in reproduction were observed; multiple clutches are indicated. No competition exists with other lizard genera, they are essentially ecologically invisible. It is possible that individual Cnemidophorus species that are in competitive associations mutually inhibit their own potential increase more than that of the other species and thus can continue to coexist. If, as presumed in this study, no species has an advantage or if reciprocating ones exist, it may be predicted that all 5 species will continue to exist in the Chihuahuan Biotic Province, but weight of numbers or chance will eventually remove all but one of them from any given association within the province.

156. —. 1958. A list of arthropods found in the stomachs of whip-tail lizards from four stations. TEXAS J. SCIENCE 10(4): 443-446.

A list as precise taxonomically as possible of the food items eaten by 1141 lizards (exsanguis, gularis, inornatus, tesselatus and tigris) is presented. Taxa are indexed relative to lizard predator and specific locality. No millipedes or lubber grasshoppers (Taeniopoda eques) and only 1 meloid beetle were eaten, indicating unpalatability.

157. —. 1959. Drift-fence trapping of lizards on the Black Gap Wildlife Management Area of southwest Texas. TX. J. SCI. 11: 150-157.

The method of trapping and weather conditions in the mesquite-huisache association are described. Cnemidophorus inornatus, C. tigris and four other species were trapped. No inornatus were recaptured. 38

tigris were marked and 23 recaptured a total of 84 times. One individual recaptured 17 times had a home range of .53 acres based on the outer polygon method. It was noted that tigris makes a low clicking sound when handled.

158. —. 1960. Supplementary notes on the herpetofauna of the Stockton Plateau. TEXAS JOURNAL OF SCIENCE 12(3/4): 228-231.

Cnemidophorus gularis and C. inornatus, which occur in the cedar-savannah association on mesa tops, were virtually wiped out by a 10-year drought while C. tessellatus went from virtually absent to quite abundant.

159. —. 1961a. Observations of the activities of small animals (Reptilia and Mammalia) on a quadrat in southwest Texas. AMERICAN MIDLAND NATURALIST 65(1): 127-138.

Drift-fence trapping was done for 5 weeks beginning in June 1 mi. E. of Alpine, Brewster County. The vegetation of the quadrat, located in the short-grass--mesquite association at 4600 feet, is described. Weather during the study period is described. 47 female and 32 male Cnemidophorus sacki (= exsanguis + gularis) were marked and released. 51 lizards were recaptured at least once for a total of 156 recaptures. The average home range was .34 (.25-.43) acres; lizards were apparently not territorial. A modified Lincoln Index gave a density estimate of 20-25 resident lizards per acre. One lizard was eaten by the snake Hypsiglena torquata. Foraging behavior is described; lizards were observed to feed upon scorpions, grasshoppers, termites, candleflies, lepidopteran larvae, and ant lions. Lizards emit an audible squeak when picked up.

160. —. 1961b. Competitive relations in lizard populations. in VERTEBRATE SPECIATION, Blair, W. F., editor. University of Texas Press, Austin. pp. 460-489.

Four species of Cnemidophorus in Trans-Pecos Texas (inornatus, sacki (= exsanguis + gularis), tessellatus and tigris) appear to present an example of competition in the absence of an advantage. They occur sympatrically within this region, although all 4 species are seldom found at any one locality, and rarely do more than 2 species occur in equal concentrations. Furthermore, no two species appear to occupy the same ecological associations in the same areas, although all 4 species do appear to occupy the same ecological niche. The diets of all 4 species are similar and have the same staple food items. There is some active intraspecific but no active interspecific competition. Foraging abilities appear to be equal or complementary, and activity periods and

reproductive potentials appear to be the same. The geographic and ecological distributions of whiptails in southwest Texas imply that, although all 4 species are capable of living in most of the ecological associations of the Chihuahuan Desert, no two of the species can simultaneously do so successfully.

161. —. 1965. Changes in competing populations of whiptail lizards (Cnemidophorus) in southwestern Texas. AMER. MIDL. NAT. 73(1): 75-80.

Population studies of C. inornatus, C. septemvittatus, and C. tigris done at the Black Gap Wildlife Management Area in 1952 were repeated in 1962. The area had recovered from a severe drought during that time span. Cnemidophorus tigris increased in density in the ecological association it dominated in 1952 as well as in the associations dominated by the other two species. Population estimates were 17.85/acre and 74.3/acre for 1952 and 1962, respectively. The two other species were quite rare in 1962. Changes in diet are documented; lepidopteran larvae had increased and termites decreased in importance. The evidence suggests a tigris "bloom" and superior short-term competing ability over the other two species based on sheer numbers. C. inornatus and C. septemvittatus are relegated to more xeric, less productive habitats.

162. —. 1977. The Black Gap whiptail lizards after twenty years. in TRANSACTIONS OF THE SYMPOSIUM ON BIOLOGICAL RESOURCES OF THE CHIHUAHUAN DESERT REGION, UNITED STATES AND MEXICO. Wauer, R. H. and D. H. Riskind, editors. National Park Service Transactions and Proceedings Series No. 3: 523-532

The Black Gap area was revisited in 1971 and 1972. The increased rainfall trend has continued. The population density of Cnemidophorus tigris has fallen from 1962 to 13.64 lizards per acre, and C. inornatus and C. septemvittatus have returned to their old habitats. An increase in groundcover and predation are two hypotheses advanced for the population phenomenon in C. tigris. Natural cyclic events and the ability of C. tigris to "bloom"—take best advantage of short-term favorable events better than other species of Cnemidophorus--are also discussed. Changes in diet over the two decades are discussed. It is concluded that termites are the staple food for Cnemidophorus during lean months and/or years, but not during periods of abundant food variability and availability.

163. —, J. S. Mecham and H. McClintock. 1950. The amphibians and reptiles of the Stockton Plateau in northern Terrell County, Texas. TEXAS JOURNAL OF SCIENCE 2(4): 543-562.

Eleven habitat associations are described for the plateau, which is considered to lie in the northeastern portion of the Chihuahuan Biotic province. Cnemidophorus grahamii (= tesselatus) was taken mostly in cedar-ocotillo at the base of mesa slopes or in mesquite-creosote not far from its margin with the former association. Both are characterized by extensive rock and sparse vegetation. Cnemidophorus gularis and C. perplexus (= inornatus) were found in cedar savannah of mesa tops and mesquite-creosote of the broad inter-mesa valleys. The former species was more common than the latter. The habitats occupied by these two species were characterized by good vegetative cover, almost impenetrable in places, and little rock.

164. —. and D. W. Tinkle. 1969. Interrelationships of feeding habits in a population of lizards in southwestern Texas. AMERICAN MIDLAND NATURALIST 81(2): 491-499.

An analysis of food items eaten by Cnemidophorus tigris marmoratus is given. It is an opportunistic feeder on arthropods, predominantly coleopterans and orthopterans. Competition with the other dominant lizard species present, Uta stansburiana, is avoided through the exploitation of different size-classes of prey. Interspecific competition for food is one explanation for the rarity of other lizard species in the study areas.

165. Minton, S. A., Jr. 1958. Observations on amphibians and reptiles of the Big Bend region of Texas. SOUTHWESTERN NAT. 3: 28-54.

Cnemidophorus tigris marmoratus is very plentiful on desert flats and sandy areas along the Rio Grande. It is less abundant in foothills and rare or absent in prairie areas or elevations above 5000 feet. Intraspecific aggression was noted. C. tessellatus was spotty in occurrence and evidently restricted to arid mountains, mesas and canyons. All specimens examined are females; no males have ever been found. C. sacki exsanguis and gularis (= C. exsanguis and C. gularis) occur on low, slightly damp, grassy sites and on hills in the sparse juniper-cholla-sotol association. They show no tendency to frequent rocky sites. C. perplexus (= inornatus) occupies prairie, desert flats and desert foothills; it does not occur on higher mountains or the Rio Grande lowlands. It is the dominant lizard in flat, open spaces almost devoid of vegetation. It likes grass and mesquite; it is absent from Larrea and yucca associations.

166. Mitchell, J. C. 1979. Ecology of southeastern Arizona whiptail lizards (Cnemidophorus: Teiidae): population densities, resource partitioning, and niche overlap. CANADIAN J. ZOOLOGY 57: 1487-1499.

The densities of 4 species of Cnemidophorus (inornatus arizonae, sonorae, tigris gracilis, and uniparens) were estimated by walking a line transect. Four study areas manifesting complex habitats are described. All species did not occur on all areas. C. inornatus densities ranged from 2.5/hectare at the end of May to 15/hectare at mid-July on the same site. C. tigris and C. uniparens ranged from 2-11 and 4.5-18 lizards per hectare, respectively, at the same times on different study areas. Only 8 C. sonoreae were seen during the entire study. Daily and seasonal activity patterns and food items were determined. Measurements of niche breadth and niche overlap were compared for syntopic species pairs and ecological differences between bisexual and unisexual species were found to be minimal. The most important niche components separating the species studied were macrohabitat, microhabitat, time, and food, although there is high overlap in the latter three. It is concluded that these 4 species form a guild of similar lizards.

167. —. and M. J. Fouquette, Jr. 1978. A gynandromorphic whiptail lizard, Cnemidophorus inornatus, from Arizona. COPEIA 1978(1): 156-59.

An individual of C. i. arizonae possessed male organs on the left side and female organs on the right side of its body internally. A photograph is presented.

168. Morafka, D. J. 1977a. Is there a Chihuahuan Desert? A quantitative evaluation through a herpetofaunal perspective. in TRANSACTIONS OF THE SYMPOSIUM ON THE BIOLOGICAL RESOURCES OF THE CHIHUAHUA DESERT REGION, UNITED STATES AND MEXICO. Wauer, R. H. and D. H. Riskind, editors. National Park Service Trans. and Proc. Series No. 3: 437-454.

The Chihuahuan Desert is defined by climatological, physiographical and vegetational criteria. It may be defined as the North American warm desert east of the Continental Divide. It possesses great internal homogeneity. Cnemidophorus inornatus, C. neomexicanus and C. tessellatus are considered to be characteristic or endemic.

169. —. 1977b. A biogeographical analysis of the Chihuahuan Desert through its herpetofauna. BIOGEOGRAPHICA, vol. 9. Dr. W. Junk B.V., the Hague. viii + 313 p.

A monumental effort. The paleoclimatology and geologic history of the Chihuahuan Desert are examined as reflected by the herpetofauna. The region encompasses 450,000 km² from latitude 22N to 35N and longitude 101W to 108W. Nine species of Cnemidophorus (burti, exsangui, flagellicaudus, gularis, inornatus, neomexicanus, tessellatus, tigris,

and uniparens) are considered here. Five of them are parthenogenetic, and all 5 are endemic to the Trans-Pecos (northernmost) subprovince of the Chihuahuan Desert. C. neomexicanus has the lowest ecologic amplitude of the 9, restricted to Chihuahuan desertscrub and desert riparian associations between approximately 600 and 750 m. elevation. C. exsanguis has the widest, occurring continuously from scrub associations at approximately 550 m. to montane coniferous forest at 2000 m. There is considerable overlap between the species at this ecologic scale with no fewer than two occurring together in any association at any elevation (and this minimum case occurs only at each extreme of the elevational continuum for the genus). The Wisconsin glaciation virtually eliminated the Trans-Pecos subprovince as a desert. The post-Wisconsin Xerothermic Period (12000-5000 years B.P.) represents an extreme in Quaternary warm arid conditions and is the most recent in an alternating series between warm-dry and cool-moist Pleistocene climatic episodes. Desert biota re-invasions of the Trans-Pecos subprovince must have taken place over huge areas in relatively short periods of time, perhaps expanding 3-5 km/year, resulting in broad ecotonal herpetofaunas often with species densities exacerbated by an edge effect. It is precisely this complex overlapping of fluctuating ecological associations (such as between desert, grassland, and pinyon-juniper woodland) that may have played a critical role in the origin of hybrid parthenogenetic Cnemidophorus. They are at present maintained in ecotonal conditions resulting from these shifts. They are absent from the other subprovinces of the Chihuahuan Desert due to historical factors and/or longer climatic stability in those regions.

170. Mosauer, W. 1932. The amphibians and reptiles of the Guadalupe Mountains of New Mexico and Texas. OCCASIONAL PAPERS OF THE MUSEUM OF ZOOLOGY, UNIVERSITY OF MICHIGAN, No. 246: 1-18.

The habitats at two collecting localities, Dark Canyon and Frijole, are described. Cnemidophorus sexlineatus sackii (= exsanguis) was the most frequently seen if not the most common reptile in the Guadalupe Mountains. It was very abundant at the bottom of Dark Canyon but much less common on its rocky slopes.

171. Munsey, L. D. 1972. Water loss in 5 species of lizards. COMP. BIOCHEM. PHYSIOL. A COMP. PHYSIOL. 43(4): 781-794.

Cnemidophorus tigris from the Mojave and Colorado deserts were used in the experiments. Lizards were kept under (a) food only and (b) no food or water conditions; tigris survived well under (a) supporting the general assumption that desert lizards balance water loss with preformed water in the diet. Water loss at 30°C. in still, relatively dry air (36% R.H.) was 0.58 mg/gr/hr. The vital exsiccation limit was 44.91 (loss in % initial body weight). C. tigris survived an average of 30 days under condition (b); one less xerically-adapted species sur-

vived only half as long whereas 3 more xerically-adapted species survived considerably longer. Interspecific water loss rates have not yet been determined in the Teiidae as yet, but the emerging pattern for reptiles is a close correlation between loss rate and degree of habitat aridity.

172. Neaves, W. B. 1969. Adenosine deaminase phenotypes among sexual and parthenogenetic lizards in the genus Cnemidophorus (Teiidae). JOURNAL OF EXPERIMENTAL ZOOLOGY 171(2): 175-184.

Electrophoresis was performed for several enzymes on various species of Cnemidophorus. Lizards from Colorado, New Mexico and Texas were used in the analyses. Adenosine deaminase (ADA) is polyallelic and controlled by a single autosomal locus. ADA phenotypes are: C. septemvittatus (ADA-1), C. gularis (ADA-2), C. sexlineatus and C. tigris (ADA-3), C. inornatus (ADA-4). Parthenogenetic species examined have the following ADA phenotypes: diploid C. tessellatus 1-3, triploid C. tessellatus 1-3-3, C. neomexicanus 3-4, C. uniparens and C. velox, 3-4-4, and C. exsanguis 2-3-4. Parthenogenetic phenotypes were compared with mixtures of suspected sexual parental phenotypes and were found to be virtually indistinguishable. Thus, diploid C. tessellatus are the result of (a) hybridization event(s) between C. tigris and C. septemvittatus. Evidence from karyotypes and lactate dehydrogenase (LDH) genotypes indicate that C. tigris and not C. sexlineatus was involved in the above event(s). The evidence likewise indicates that triploid C. tessellatus arose from cross(es) between diploid tessellatus and C. sexlineatus. C. sexlineatus is also homozygous for an allele of 6-phosphogluconic acid dehydrogenase (PGD) not found in the other sexual species; triploid tessellatus possess this allele in a single dose with a double dose of the other allele. The evidence also indicates that C. tigris X C. inornatus event(s) led to C. neomexicanus. The origins of the remaining 3 parthenospecies is unclear, and does not appear on the basis of available evidence to involve any possible combination of the 5 sexual species studied here. For each enzyme surveyed among the parthenospecies, only a single characteristic heterozygous genotype was observed in all individuals of each species. This, plus evidence from histocompatibility work, suggests that all diploid tessellatus may be genetically identical and hence derived from one unique interspecific hybridization.

173. —. 1971. Tetraploidy in a hybrid lizard of the genus Cnemidophorus (Teiidae). BREVIORA 381: 1-25.

A hybrid C. exsanguis X C. inornatus collected from a weed bed between railroad tracks and the city zoo in Alamogordo, New Mexico, possesses a tetraploid chromosome complement. The hybrid habitat supports dense populations (50 and 10 lizards per acre, respectively) of the two parental species. A detailed description of the aberrant li-

zard is given, including behavior in captivity where it laid 2 eggs. Captive courtship and mating behavior between C. inornatus males and C. exsanguis and C. tessellatus females is described in detail. This type of behavior is probably due to (or at least facilitated by) crowding in captivity, but since the population from which the natural hybrid came from was dense, perhaps overcrowding (high density) is required for interspecific hybridizations to occur. The cytological events leading to tetraploidy in Cnemidophorus are discussed, and a very interesting summary of genetic mechanisms of parthenogenesis and the implications thereof is given. It is suggested here that triploid C. tessellatus arose from a single hybridization event between diploid tessellatus and C. sexlineatus. The absence of tetraploid species of Cnemidophorus is attributed to the rarity of achieving parthenogenetic competence in interspecific hybrids. Interspecific hybrids are not rare (witness the C. perplexus situation plus events like the aberrant individual reported on here) so the achievement of parthenogenetic competence is the critical event.

174. —. and P. S. Gerald. 1968. Lactate dehydrogenase isozymes in parthenogenetic teiid lizards (Cnemidophorus). *SCIENCE* 160: 1004-1005.

Lactate dehydrogenase (LDH) isozymes consist of two distinct subunits, A & B, associated in tetramers; there are thus 5 possible subunit combinations. Subunit synthesis is controlled by structural genes at two distinct loci, a & b. The sexual species Cnemidophorus tigris, C. inornatus and C. gularis, and the parthenogenetic species C. exsanguis all possess the same A subunit, but C. tigris possesses a B variant, B'. Electrophoresis of C. neomexicanus and C. tessellatus E reveal more than 5 possible LDH subunit combinations (= heterozygosity), thus 3 different subunits (A, B, and B') must be present. C. tigris is therefore implicated as one parent for both of the preceding hybrid parthenogenetic species. Electrophoretic patterns reported on here are very similar to those of other vertebrate hybrids, both natural and artificial.

175. —. and —. 1969. Gene dosage at the lactate dehydrogenase locus in triploid and diploid teiid lizards. *SCIENCE* 164: 557-558.

The densities of electrophoretic bands of heterozygous triploid Cnemidophorus tessellatus are unequal, showing higher proportions of B over B' subunits of LDH. These proportions are consistent with the explanation that each allele is expressed equally, therefore the diploid tessellatus genotype is b'/b and the triploid genotype b'/b/b. The b' allele is contributed by C. tigris and the b allele by one or more species of the sexlineatus group of Cnemidophorus.

176. Nickerson, M. A. and C. E. Mays. 1969. A preliminary herpetofaunal analysis of the Graham (Pinaleno) Mountain region, Graham County, Arizona with ecological comments. TRANSACTIONS OF THE KANSAS ACADEMY OF SCIENCES 72(4): 492-505.

Cnemidophorus exsanguis (= probably flagellicaudus) occurs between 4000 and 5000 feet, most commonly along drainage channels with Quercus or open areas with Juniperus. C. tigris gracilis is very abundant below 4600 feet, but most common between 3200 and 4400 feet in elevation. It occupies relatively open Prosopis-Acacia-Opuntia desert, moving at the periphery of shrubs. C. uniparens occurs from 3200 to 5000 feet in riparian habitats along streams and washes.

177. Parker, E. D., Jr. 1979a. Ecological implications of clonal diversity in parthenogenetic morphospecies. AMER. ZOOL. 19(3): 753-762.

Female parthenogenesis has repeatedly evolved in most major animal and plant groups. Although the taxonomic distribution of parthenogenetic "morphospecies" suggests that they are unsuccessful over evolutionary time, parthenogenesis ranks as one of the major exceptions to the Mendelian cycle of meiosis and fertilization. Data summarized indicate that most, if not all, secondarily-evolved parthenogenetic morphospecies are clonally diverse. The nature of interactions among sympatric clones of such species are presently ambiguous. Factors influencing the dynamics of clonal diversity include (1) the mode of clonal origin (2) the pattern of environmental heterogeneity (3) vagility and (4) interactions with sexual ancestors. The outcome of competition between a parthenogenetic taxon and its sexual ancestors is unclear. Models can be generated which give any outcome depending on initial assumptions and the role of clonal diversity in the parthenogen has received little attention. The polyphyletic diploid morphospecies Cnemidophorus tessellatus is characterized by low clonal diversity and the presence of one dominant clone. Much stronger selection is envisioned among polyphyletic clones because of their greater genetic differences than among monophyletic clones. This distinction will become blurred with time, but this has not occurred yet as the affinities of clones to each other and their ancestral species can still be determined by electrophoresis. Unpublished data is reported which shows that Cnemidophorus neomexicanus has low clonal diversity with only 2 clones detected over the entire species range and with no multiclonal populations.

178. —. 1979b. Phenotypic consequences of parthenogenesis in Cnemidophorus lizards. I. Variability in parthenogenetic and sexual populations. EVOLUTION 33(4): 1150-1166.

Morphological consequences of parthenogenesis in Cnemidophorus tessellatus were studied as reflected in the concordance of morphological variation with electrophoretically-detected clonal heterozygosity.

The relative amounts of phenotypic variation in populations differing in clonal structure were compared with populations of one parent species, C. tigris. C. tessellatus consists of at least 18 diploid and 3 triploid clones. The presence at some loci of different heterozygous genotypes involving different electrophoretic morphs found in the parental sexual species suggests multiple hybridizations as a major factor in generating clonal diversity. The presence of unique alleles in some clones and histocompatibility between pattern classes indicate that some clones may have diverged from a common ancestral clone. 14 morphometric characters of the two species were subjected to univariate and multivariate analyses. Six of 23 tessellatus populations sampled are multiclonal. Seven clones were discovered at Conchas, San Miguel County, New Mexico; heterozygosity at one locus is probably due to multiple hybridizations. The population at Higbee, Otero County, Colorado consists of both diploid and triploid individuals. Diversity in the remaining 4 multiclonal populations was low with no detectable morphological variation among clones. Variability in size- or growth-related characters adjusted for allometry and covariation with size is similar in both species. Variation in 6 of 9 scale characters differs consistently as expected between sexual and parthenogenetic populations.

How the sympatric clones of the tessellatus complex coexist is unknown. Specimens from the two most clonally diverse populations reported here were collected on weedy roadsides and around trash piles and abandoned houses; perhaps clonal diversity is the result of nondirectional environmental perturbations which have not permitted any one clone to competitively replace the others. However, the morphological discontinuities among clones may very well reflect differences in niche utilization or physiological attributes. It is suggested that environmentally-induced variability obscures genetic variability of size characteristics measured in the two species. It is also suggested that the genotypes of parthenogenetic and sexual taxa differ in their phenotypic responses to environmental change. Genetic variability for phenotypic plasticity in a sexual ancestor will be "fixed in" to different degrees in different clones; eventually in temporally or spatially changing environments surviving clones may be highly flexible general-purpose genotypes. Interactions among genes may be qualitatively different in parthenogenetic and sexual genomes. Epistasis and dominance between the parental genomes of diploid tessellatus are more important than additive effects in determining mean character values in this study, whereas in sexual species genes are selected primarily for their additive effects. The mutational load carried by clonal lineages is greater than in individuals of sexual species, although this does not seem to be the case in Cnemidophorus tessellatus. Naturally occurring parthenogenetic organisms would appear to be useful models for examining relationships among genotype, phenotype, and ecology of populations.

179. —. 1979c. Phenotypic consequences of parthenogenesis in Cnemidophorus lizards. II. Similarity of C. tessellatus to its sexual parental species. EVOLUTION 33(4): 1167-1179.

The understanding of the evolution of sexual reproduction hinges on how organisms resolve the conflict between immediate genetic fitness and maintenance of genetic flexibility. Parthenogenetic individuals maximize their genetic representation in future generations and maintain any adaptive gene combinations. Sexual individuals produce genetically diverse offspring (and populations) which may be less prone to extinction in uncertain environments. Comparative genetic, morphological, and ecological studies of related parthenogenetic and sexual populations are critical.

Multivariate analyses were done on 13 morphological traits of diploid and triploid population samples of Cnemidophorus tessellatus and females of the parental species C. septemvittatus, C. tigris and C. sexlineatus. Comparisons were made only from broad areas of sympatry. Characters for diploid tessellatus were summarized in a weighted hybrid index which maximized the separation between the two parental species. Diploid tessellatus were phenotypically closer to septemvittatus when all 13 characters were compared. They were closer to tigris when the 9 scale characters were considered alone, and intermediate between the two parental species when the 4 size-correlated characters were considered alone. The first two character groups also differentiate the two parental species well from each other whereas the latter group does not. Triploid tessellatus are phenotypically closer to diploid tessellatus than to sexlineatus in all cases. However, the estimated probability that any given unknown sample of triploid tessellatus will actually belong to one of the parental groups is less than .001. No diploid population has a probability greater than .01 of belonging to either parental species when all 13 characters are considered. All diploid populations have a probability greater than .05 of belonging to either of the parental species when size characters are considered alone; when considering the 9 scale characters alone, 17 of 51 diploid samples have a probability greater than .05 of belonging to C. tigris.

Most characters in diploid tessellatus show dominance or overdominance in averages and wide ranges of expression among clones and populations, indicating differing epistatic or genotype-environment interactions between the various parental genomes responsible for the origin of diploid tessellatus. Two and four unique clones occur in the vicinity of Engle (Sierra Co.) and Conchas Lake (San Miguel Co.), New Mexico, respectively, indicating multiple hybridizations between septemvittatus and tigris. It is suggested, based on this, current distribution and possible distributional history, major habitat preferences, and similarities in size, that C. tessellatus and female C. septemvittatus compete with each other and are in ecological, if not evolutionary, equilibrium. The implication is that tessellatus is competitively superior under certain conditions. It is suggested that this can be tested with experimental field studies comparing reproduction in sympatry and allopatry. Multiple hybridizations are the most important source of morphological heterogeneity in C. tessellatus, which represents a complex of clonal microspecies. The effects of this heterogeneity among clones on their fitness are unknown; it is likely that discontinuities reflect differences in adaptation, allowing local or regional coexistence of clones.

180. — and R. K. Selander. 1976. The organization of genetic diversity in the parthenogenetic lizard Cnemidophorus tesselatus. GENETICS 84(4): 791-805.

An analysis of allozymic variation in proteins encoded by 21 loci of diploid and triploid populations of C. tesselatus sampled throughout its range, as well as selected samples of the parental species (sexlineatus and tigris marmoratus in New Mexico), is reported. All triploid tesselatus represent a single clone, but 12 different diploid clones were identified with 1 to 4 clones recorded in each population sampled. Three possible sources of clonal diversity are discussed. It is suggested that C. tesselatus is of relatively recent origin and that the evolutionary potential of it and other parthenoforms is not as limited as heretofore considered.

181. Parker, W. S. 1972. Ecological study of the Western Whiptail lizard, Cnemidophorus tigris gracilis, in Arizona. HERPETOLOGICA 28 (4): 360-369.

Seasonal activity, growth rates, tail-break frequency, population structure and density, and reproduction are discussed. Comparisons are made with earlier studies on this and other species. The mean distance between captures was 16.2 m for 29 immatures and 21.9 m for 53 adults. Tail-break frequency was relatively low in juveniles (5-10%) and high in adults (30-56%). Growth rates ranged from 1.3 mm/month in adults to 5.0 mm/month in juveniles. Some juveniles reached minimum adult size in less than one year, but others did not do so until almost 2 years old. Females were gravid from April to early August and laid at least 2 clutches averaging 2.05 eggs each. Males had enlarged testes from March through July. About 70-80% of the population was potentially reproductive during the breeding season. Hatchlings emerged from mid-June or early July through September. C. tigris gracilis appeared equally abundant on 2 flatland desert and 3 low altitude (450-500 m) montane study areas. Density in a third flatland area was about 13/hectare in spring and 36/hectare in late summer. Lack of male territoriality is inferred from the presence of 5 male and 2 female lizards in the same pitfall trap on one occasion. No aggressive behavior was observed in over 400 hours of field work.

182. —. 1973. Notes on reproduction of some lizards from Arizona, New Mexico, Texas and Utah, USA. HERPETOLOGICA 29(3): 258-264.

Cnemidophorus exsanguis and C. tesselatus from southern New Mexico lay 2 clutches per year. Gravid females of the former were collected from May 24 to July 12. Females collected on 14 and 29 June were beginning their second clutch. Gravid females of the latter species

averaged 92 mm SVL (range 82-101). Clutch size was $3.9 \pm .53$ (1-6). Egg weight was 11-12% of body weight. Immatures ranged from 56-79 mm SVL. Adult females were collected from 10 May to 10 August. Oviducal eggs were found from 24 May until 12 July. C. tigris seasonal and sexual activity is shorter in Utah than in Arizona and New Mexico. The length of male sexual activity in Arizona > New Mexico-Texas > Utah. The average size of mature males in Utah > New Mexico-Texas > Arizona. Females possess oviducal eggs for 1 month in Utah, 2 months in New Mexico and Texas, and 3 months in Arizona. The frequency of gravid females collected peaked in June-July in Utah, declined steadily between May and July in New Mexico and Texas, and peaked in April and June in Arizona. Utah females averaged twice as many eggs per clutch than the others; the pattern of female size at maturity followed that of males. Hatchlings were first seen 4 September in Utah, 1 August in New Mexico, and 14 June and 7 July in two different years in Arizona. Fat body cycles are described.

183. Pennock, L. A. 1965. Triploidy in parthenogenetic species of the Teiid lizard genus Cnemidophorus. SCIENCE 149(3683): 539-540.

The somatic cells of Cnemidophorus neomexicanus, C. tigris septentrionalis, C. velox, C. tessellatus and C. exsanguis possessed 46, 46, 68, 69, and 70 chromosomes, respectively; therefore, the latter three are triploid. The generalized karyotype is described. The triploids appear to consist of 3 separate sets of chromosomes rather than a complement resulting from fragmentation of the basic set found in bisexual species.

184. —. 1966. A karyotype study of parthenogenetic species in the Teiid lizard genus Cnemidophorus from southwestern United States. PH.D. DISSERTATION, UNIVERSITY OF COLORADO. 96 p.

Several species (gularis, inornatus and 3 subspecies of tigris (probably gracilis, marmoratus and septentrionalis)) possess a 2N chromosome number of 46. The first two species' karyotypes are nearly identical in appearance and have a fundamental number of 48. The latter species' fundamental number is 52. C. perplexus (= neomexicanus), C. velox, C. tessellatus, C. uniparens and C. exsanguis possess chromosome complements of 46, 68, 69, 69, and 69-70, respectively; the first species is diploid and the remainder triploid. C. inornatus and C. tigris are implicated as the parental species of C. perplexus. The remainder of the parthenogenetic species can be derived, although not unequivocally, karyotypically from various combinations of inornatus and tigris. Karyotypic variation is found in different populations of exsanguis. The author is opposed to formal taxonomic revisions within these parthenogenetic species until variation within them is better understood (from abstract).

185. Pianka, E. R. 1966. Convexity, desert lizards, and spatial heterogeneity. *ECOLOGY* 47(6): 1055-1059.

Ten flatland desert sites were studied from southern Idaho to southern Arizona. The number of lizard species present in each area was correlated with horizontal and vertical components of spatial heterogeneity (vegetation and possibly substrate). Each area had from 4 to 10 species, increasing from north to south, out of a possible total of 12. Convexity is defined as the sum total of variables regarding food preferences, substrate characteristics, and foraging behavior. Cnemidophorus tigris is the only teiid represented; it exploits the environment by constantly moving from cover to cover, pausing occasionally to dig or climb for prey. It is the only widely foraging diurnal species in this system, and is thus the most "convex".

186. —. 1967. On lizard species diversity: North American flatland deserts. *ECOLOGY* 48(3): 333-351.

This study encompassed the Great Basin, Mojave and Sonoran deserts; Cnemidophorus tigris was the only teiid present. Eight mechanisms for the determination of species diversity using lizards are examined. It is concluded that ecological time, spatial heterogeneity, length of growing season, and amount of warm season productivity are all pertinent factors, but that the most important single factor is spatial heterogeneity (mainly vegetative) of the environment. It is suggested that climatic variability allows the coexistence of many different plant life forms, the variety of which in turn controls the number of lizard species present. This study spotlights the lack of same in New Mexico where lizards, particularly the genus Cnemidophorus, are very diverse in desert environments (opinion of this reviewer).

187. —. 1970. Comparative autecology of the lizard Cnemidophorus tigris in different parts of its geographic range. *ECOLOGY* 51: 703-707.

The subspecies tigris, gracilis and aethiops were studied from southern Idaho through northern Sonora. Lizards in the north emerge in May and aestivate during midsummer months; those in the south are active from April through late August. Daily activity periods are similar for all populations studied, although time of emergence tends to be later in the north. Daily patterns are bimodal with much more activity in the morning than the afternoon. There is a significant positive correlation between estimated lizard abundances and total precipitation during the previous 5 years, suggesting that abundance is correlated with food supply. There is a latitudinal cline exhibited in mean body temperature of active lizards; lizards of northern populations are ac-

tive at lower air and body temperatures. Termites are the major food for southern populations, beetles and grasshoppers for northern populations. Seasonal food trends are evident; insect larvae are an important early food source for all populations. Lizards eat a wide variety of food types where primary productivity is low and specialize more where it is high. Greater food competition with other lizard species in the south as well as the lack of termites in the Great Basin desert may account for some of these differences, in the opinion of the author of this review. Foraging behavior is described. Southern populations are subject to greater predation. Fat body size is not correlated with latitude but is inversely correlated with long-term average annual precipitation. It is suggested that lizards from less productive areas must allow themselves a greater margin of safety due to more probable occurrence of drought. Northern lizards breed only once a year but lay significantly larger clutches than southern lizards, which lay at least 2 clutches annually. Clutch size appears to be flexible in response to resource availability. There is a significant correlation between mean clutch size and deviation of the short-term (last 5 years) mean precipitation from long-term mean precipitation. Ecological challenges for northern lizards are primarily physical and largely climatic, whereas biotic interactions assume relatively greater importance for southern lizards.

188. Pietruszka, R. D. 1981a. An evaluation of stomach flushing for desert lizard diet analysis. *SOUTHWESTERN NATURALIST* 26: 101-105.

The latest on the technique is reported, with Cnemidophorus tigris from Nevada one of 5 species used.

189. —. 1981b. Use of scutellation for distinguishing sexes in bisexual species of Cnemidophorus. *HERPETOLOGICA* 37(4): 244-249.

Males of several species of Cnemidophorus (including gularis, inornatus, sexlineatus and tigris from New Mexico) possess a row of slightly to distinctly enlarged scales on either side of the ventral surface of the tail, distally separated from the vent by 2-4 granular scales, called the postanal ridge. Immediately posterior to each ridge is a distinctly shaped enlarged scale, the postanal plate. Females possess the former but not the latter. The utility for use of this character in field studies in view of the lack of other reliable sex determining mechanisms is discussed, along with variation of the trait. Small series of several parthenogenetic species demonstrate only the female characteristic.

190. Presch, W. 1974a. Evolutionary relationships and biogeography of the macroteiid lizards (Family Teiidae, Subfamily Teiinae). *BULL-*

An analysis of 25 osteological character states is presented for 9 genera; species of Cnemidophorus used include burti, exsanguis, gularis, inornatus, neomexicanus, sexlineatus, sonorae, tigris, uniparens and velox. The genus was extant during the Oligocene and evolved in isolation from other genera of the family in North America through much of the Cenozoic.

191. —. 1974b. A survey of the dentition of the macroteiid lizards (Teiidae: Lacertilia). HERPETOLOGICA 30(4): 344-349.

The dental morphology and tooth types are described for 9 genera, including all the species of Cnemidophorus mentioned in the previous paper. The genus can be divided into two groups based on the criteria.

192. Punzo, F. 1976. Analysis of the pH and electrolyte components found in the blood plasma of several species of west Texas reptiles. JOURNAL OF HERPETOLOGY 10(1): 49-52.

Data are presented for the first time for Cnemidophorus exsanguis.

193. Rickart, E. A. 1976. A new horned lizard (Phrynosoma adinognathus) from the early Pleistocene of Meade County, Kansas, with comments on the herpetofauna of the Borchers locality. HERP. 32(1): 64-67.

Cnemidophorus cf. sexlineatus is present, and comments on paleo-climatology are made.

194. —. 1977. Pleistocene lizards from Burnet and Dark Canyon caves, Guadalupe Mountains, New Mexico. SOUTHWESTERN NATURALIST 21(4): 519-522.

Cnemidophorus spp. are included in the fauna. Species composition indicates altitudinal fluctuation of vegetation zones in the Guadalupe Mountains due to climatic changes during the late Wisconsin.

195. Ruthven, A. G. 1907. A collection of reptiles and amphibians from southern New Mexico and Arizona. BULLETIN OF THE AMERICAN MUSEUM OF NATURAL HISTORY 23: 483-603.

The collection was made during July and August in the vicinity of Alamogordo, New Mexico, and Tucson, Arizona, respectively. The habitats, geology and climate of the areas is described, as well as specific collecting sites. Cnemidophorus gularis (= exsanguis) is common at Alamogordo in the lower part of canyons and in stony arroyos on alluvial slopes. It (= flagellicaudus and/or sonorae) occurs in the same habitats at Tucson, as well as along the Santa Cruz river in willow-poplar associations. Other habitat and morphological details are given. Beetles and ants make up the bulk of the stomach contents. Cnemidophorus melanostethus (= tigris + possibly tesselatus) is very common in the creosotebush association of alluvial slopes near Alamogordo and is exclusive to it there. It (= tigris) occurs in greasewood plains and creosotebush of mesa arroyos near Tucson. Behavior and morphology are discussed. C. sexlineatus (= inornatus) occurs in the mesquite and Atriplex associations and on the White Sands near Alamogordo. Ants, grasshoppers and spiders are eaten. Morphology is described.

196. Saxon, J. G. 1968. Sexual behavior of a male Checkered Whiptail lizard, Cnemidophorus tessellatus. SOUTHWESTERN NATURALIST 13(4): 454-455.

The specimen was collected 1 mile east of Presidio, Texas, in the Rio Grande valley. Cnemidophorus tigris was sympatric. Sexual behavior between the male and a female tesselatus is described. Motile sperm were produced by the male but none were present in the female and she never became gravid.

197. —. 1970. The biology of the lizard, Cnemidophorus tessellatus, and effects of pesticides upon the population in the Presidio Basin, Texas. PH.D. DISSERTATION, TEXAS A & M UNIVERSITY. 90 p.

The Presidio Basin is limited to the floodplain of the Rio Grande. Its soils, vegetation and agriculture are characterized. Black and white photographs of the study areas and of C. tessellatus (juvenile-subadult-adult) are provided. Cnemidophorus tessellatus is mostly confined to the Basin in this area. It occurs in isolated populations but not only in rocky areas—it is also found in backyards and abandoned lots in the town of Presidio, and on levee and farm roads. It is associated with disturbed areas where it is found on surrounding desert mesas. Daily activity is confined between 9 a.m. and 3 p.m.; soil and air temperatures at the beginning of activity are 32 and 30°C, respectively. Cloacal temperatures of active lizards average 39.5°C. Gravid lizards have apparently restricted activities. Domestic cats are by far the most important predator, with snakes next. The activity season extends from March to November with the bulk occurring from mid-May to mid-August. Soil temperature is the critical factor for activity. Hatchlings appear at the beginning of July and grow to subadult size (50-69 mm) before entering hibernation. Lizards rare-

ly live to their fourth, and never to their fifth, activity season. Yolke follicles are present in April and oviducal eggs in May-June. The minimum reproductive size and age is 70 mm SVL and 13-14 months, respectively. Two clutches per year averaging 3.7 (1-8) eggs each are laid, larger females laying larger clutches. Incubation time is 63 days; other reproductive aspects are discussed. Fat bodies are depleted during the reproductive season and are replenished before hibernation. They are used mainly for the first clutch and not the second. Fat is also stored in the tail. All fat is used mainly for reproduction. 5 senile females (very large fat bodies and minute or non-existent ovaries during the reproductive season) were collected; they are probably 4th-year females. Pesticides are not retained from one activity season to the next. The diet of lizards was analyzed; lepidopteran larvae were the most important food item followed by orthopterans and spiders. Pesticides were acquired through food ingestion. Lizards avoided cotton rows next to roads and levees where the pesticide concentration was very high. They became active in the morning after spraying was completed and thus were not directly exposed. Fat mobilization for the first clutch occurred in May whereas heavy application of pesticides did not occur until June. Fat body replenishment occurs after pesticide application decreases, therefore this species is potentially exposed to minimal hazards from pesticides.

198. —, H. G. Applegate and J. M. Inglis. 1967. Male Cnemidophorus tessellatus (Say) from Presidio, Texas. TEXAS J. SCIENCE 19(2): 233-234.

A photograph of a specimen with fully developed testes and reproductive organs collected on alluvial soil of the Rio Grande valley 1 mi. E. of Presidio is provided. The area was formerly cultivated and is now wild. The specimen is morphologically described.

199. Schall, J. J. 1977. Thermal ecology of 5 sympatric species of Cnemidophorus (Sauria: Teiidae). HERPETOLOGICA 33(3): 261-272.

Five species (exsanguis, gularis, inornatus, tesselatus and tigris) were studied in the Big Bend region of Texas. All have different habitat associations, which are briefly discussed. Thermal characteristics vary among each of 3 microhabitats within 5 major habitats studied. Data on 3 different environmental temperatures and body temperatures taken during 3 different types of behavior are given for each species. Differences in thermal characteristics are thought to reflect fundamental behavioral differences between species. Thermoregulatory behavior in the wild and of 2 species (exsanguis and tesselatus) in artificial thermal gradients is discussed. Overall mean body temperatures of actively moving lizards are very similar among the species studied and suggests that optimal body temperature is an evolutionally conservative trait of whiptails. Cnemidophorus has among the highest

body temperature values recorded of any lizard genus. Species variation in thermal characteristics reported is due to recently evolved differences in habitat niches, individual seasonal differences associated with reproductive and nutritional state, and behavioral trade-offs between maintaining the optimal body temperature and maintenance activities such as foraging.

200. —. 1978. Reproductive strategies in sympatric Whiptail lizards (*Cnemidophorus*): 2 parthenogenetic and 3 bisexual species. COPEIA 1978(1): 108-116.

Cnemidophorus exsanguis, *C. gularis*, *C. inornatus*, *C. tessellatus* and *C. tigris* were studied in southwest Texas. If the unisexual species are animal weeds, they should possess relatively r-selected reproductive traits compared to sympatric bisexual forms. Reproductive effort (RE) was estimated by clutch weight to body weight ratios. RE varies interspecifically, partly as a result of differential habitat preference and productivity. Clutch size and egg weight is partially correlated with female body size. A minimum egg size is suggested; too small and young cannot compete successfully. No differences in RE were observed between the bisexual and unisexual species studied here, except for the higher intrinsic rate of increase for the parthenoforms. Reproductive strategy of a particular species of *Cnemidophorus* is probably related to its ecological position. Any differential selective factors operating on static reproductive characteristics may be overshadowed by constraints imposed by body form, size, and foraging techniques.

201. —. and E. R. Pianka. 1980. Evolution of escape behavior diversity. AMERICAN NATURALIST 115(4): 551-566.

This paper examines the hypothesis that escape tactic diversities should vary positively with predation pressure among conspecific prey populations and escape tactics should diverge among similar sympatric species that share predators. Escape behavior was quantified for *Cnemidophorus tigris* at many sites where it occurs alone and for an assemblage of *Cnemidophorus* species (*exsanguis*, *gularis*, *inornatus*, *tessellatus* and *tigris*) in southwest Texas. Predation pressure was estimated by tail-break frequencies. Escape behaviors are described for species. Sympatric whiptail species differ significantly in escape behavior; escape behaviors are more divergent than if each species evolved escape tactics independently of other species in a random fashion. *Cnemidophorus tigris* exhibits a reduced tail-break frequency in southwest Texas than at more westerly sites where it occurs alone but with presumed similar predation pressures, perhaps as a result of increased protection offered by a species assemblage with diverse escape behaviors.

202. Schmidt, K. P. and T. F. Smith. 1944. Amphibians and reptiles of the Big Bend region of Texas. FIELD MUSEUM OF NATURAL HISTORY ZOOLOGICAL SERIES 29(5): 75-96.

Habitat differences are sharply defined between Cnemidophorus grahamii (= tesselatus), which lives in canyons, and C. tessellatus (= tigris), which occupies desert flats or plateaus.

203. Schrank, G. D. and R. E. Ballinger. 1973. Male reproductive cycles in two species of lizards (Cophosaurus texanus and Cnemidophorus gularis). HERPETOLOGICA 29(3): 289-293.

Histological studies were done on specimens from Tom Green County, Texas. Males emerge from hibernation with relatively small testes which rapidly increase in size to a maximum in May followed by gradual gonadal regression until September. This parallels female ovarian cycles. Fat bodies are almost depleted during the cycle.

204. Scudday, J. F. 1971? The biogeography and some ecological aspects of the Teiid lizards (Cnemidophorus) of Trans-Pecos Texas (August 1971). Ph.D. DISS., TEXAS A & M UNIVERSITY. 198 p.

Field studies of sympatric relationships among Cnemidophorus exsanguis, C. gularis gularis, C. inornatus heptagrammus, C. tessellatus E and C. tigris marmoratus were conducted to obtain a better understanding of speciation processes in the genus. Populations of all the species in the region were compared morphologically and 2 new pattern classes of C. tessellatus described. Geographic and ecological distributions are discussed in detail. Minor differences in food items between species are thought to be important during adverse times. Species behaviors are discussed; C. inornatus heptagrammus was found to be the most aggressive species under captive conditions. Foraging behavior was found to be a significant measure of niche separation. Reproduction was investigated; all species produced 2 clutches a year. Unbalanced sex ratios favoring males found in C. tigris marmoratus is thought to be a contributing factor in the hybrid origin of C. tessellatus. Ecological and evolutionary sympatry and competition is discussed. Changes in species composition and density due to yearly climatic fluctuations were observed.

205. —. 1973. A new species of lizard of the Cnemidophorus tessellatus group from Texas. J. HERPETOLOGY 7(4): 363-371.

Cnemidophorus dixonii is formally named, and morphological descriptions and a diagnosis are given. Differences in color pattern are the

most distinguishing features between C. dixonii and C. tessellatus; the most important differences are ecological. The geographic distribution and habitat of C. dixonii in west Texas is discussed in detail, and the sympatric ecological relationships with C. tessellatus and its generating species is discussed. Two pattern classes (A & B) of C. dixonii are recognized; C. tessellatus F from Hidalgo County, New Mexico, is referred to C. dixonii B. (The author of the present review has important comments on this paper in the introduction).

206. —. 1977. Some recent changes in the herpetofauna of the northern Chihuahuan Desert. in TRANSACTIONS OF THE SYMPOSIUM ON THE BIOLOGICAL RESOURCES OF THE CHIHUAHUAN DESERT REGION, UNITED STATES AND MEXICO. Wauer, R. H. and D. H. Riskind, eds. Natl. Park Service Trans. & Proceedings Series No. 3: 513-522.

There has been an increase in Cnemidophorus tigris populations in the Fort Stockton, Texas, area at the expense of C. gularis and C. inornatus over the last several decades due to increased human-influenced aridity.

207. —. and J. R. Dixon. 1973. Diet and feeding behavior of Teiid lizards from Trans-Pecos Texas. SOUTHWESTERN NAT. 18(3): 279-289.

Food items eaten and foraging behavior are discussed in detail for Cnemidophorus exsanguis, C. gularis, C. inornatus, C. tessellatus E and C. tigris. It is concluded that minor differences existing between the species in types and proportions of food items eaten could be important in adverse times. Foraging behavior among sympatric species represents differences in methods of obtaining food, and thus represents niche segregation.

208. Smith, D. D. 1974. Population structure, growth and reproduction of two species of Cnemidophorus; one unisexual and one bisexual. HERPETOLOGICAL REVIEW 5(3): 77-78.

Cnemidophorus exsanguis and C. gularis were studied in Brewster County, Texas. Individuals of the former species reached reproductive maturity at the age of 10 months, but most females of the latter species did not mature until their second potential reproductive season. Snout-vent lengths and clutch size were directly proportional. Older females of both species produced 2 clutches per year.

209. Smith, H. M. and H. K. Buechner. 1947. The influence of the Balcones Escarpment on the distribution of amphibians and reptiles in

Texas. BULLETIN CHICAGO ACADEMY OF SCIENCES 8(1): 1-16.

The escarpment is described relative to its location, climate and vegetation. Its influence on herpetofaunal distributions is discussed. Cnemidophorus gularis gularis and C. sexlineatus reach their eastern and western range limits in Texas here, respectively.

210. —. and W. L. Burger. 1949. The identity of Ameiva tessellata Say. BULLETIN CHICAGO ACADEMY OF SCIENCES 8(13): 277-284.

The correct and currently recognized assignment of the names C. tessellatus (Say) and C. tigris Baird and Girard is made.

211. —, T. P. Maslin and R. L. Brown. 1965. Summary of the distribution of the herpetofauna of Colorado; a supplement to an annotated check list of the amphibians and reptiles of Colorado. UNIVERSITY OF COLORADO STUDIES, SERIES IN BIOLOGY No. 15: 1-52.

A supplementary list of published accounts and records, as well as range maps, are given for several species of Cnemidophorus (sexlineatus, tessellatus, tigris septentrionalis and velox) in Colorado.

212. Specian, R. D. and J. E. Ubelaker. 1974. Two new species of Pharyngodon Diesing, 1861 (Nematoda: Oxyuridae) from lizards in west Texas. PROC. HELMINTHOLOGICAL SOC. WASH. 41: 46-51.

P. cnemidophori in Cnemidophorus tigris and P. warneri in C. inornatus represent new host and distributional records, respectively.

213. Stevens, T. P. 1980. Notes on thermoregulation and reproduction in Cnemidophorus flagellicaudus. J. OF HERPETOLOGY 14(4): 418-420.

The species' habitat in the Mazatzal Mountains of eastern Arizona is briefly described. Average body temperature was 39.9 ± 0.3 degrees C. Clutch size was 4.3 ± 0.4 eggs; only one clutch per year was produced. Egg production began in early May and eggs were deposited in June-July. Lizards began stockpiling body fat in August and entered brumation by September.

214. Strecker, J. K., Jr. 1910. Notes on the fauna of a portion of the Canyon region of northwestern Texas. BAYLOR UNIV BULL 13: 1-31.

The Paloduro region consists of a series of canyons and draws, with scattered cottonwoods and willows in their bottoms. Other vegetation includes scrub oaks, Opuntia, bear grass and various shrubs. Elevations range between 2800 and 3600 feet. Cnemidophorus gularis is abundant in some areas, but not where C. grahamii (= tesselatus) occurs. The former species prefers sandy level areas and the latter rocky bluffs. C. grahamii (= tesselatus) does not attempt to escape into or even use burrows, but seeks shelter under rocks (perhaps because they are abundant). The species was particularly common in Rush Creek Arroyo around large sandstone rocks on bluffs surrounding a series of small springs. One individual was found depositing eggs in loose sand near the base of a shelving bank. Morphological descriptions of adults and young are given.

215. Tanner, D. L. 1975. Lizards of the New Mexican Llano Estacado and its adjacent river valleys. STUDIES IN NATURAL SCIENCES, EASTERN NEW MEXICO UNIVERSITY 2(2): 1-39.

A list of museum specimens is given and localities individually plotted on range maps. Species of Cnemidophorus included are exsanguis, gularis, inornatus, sexlineatus, tesselatus and tigris.

216. Tanner, W. W. and J. E. Krogh. 1974. Variations in activity as seen in 4 sympatric lizard species of southern Nevada, USA. HERPETOLOGICA 30(3): 303-308.

The abundance of Cnemidophorus tigris on a daily and seasonal basis was determined in a lizard community of 4 species on the Nevada Test Site. Individuals of C. tigris were found to escape capture best at the time of day when the species was most abundant; the significance of this is discussed.

217. Taylor, E. H. 1938. Notes on the herpetological fauna of the Mexican state of Sonora. KANSAS UNIV SCIENCE BULLETIN 24: 475-503.

Cnemidophorus burti is formally named, described and diagnosed. The type locality is "near La Posa, 10 mi. NW Guaymas". A photograph of the type, which is lined with no spots, is provided.

218. —. 1940. Palatal sesamoid bones and palatal teeth in Cnemidophorus, with notes on these teeth in other saurian genera. PROCEEDINGS OF THE BIOLOGICAL SOCIETY OF WASHINGTON 53: 119-124.

Palatal sesamoid bones and teeth are present in several species

of Cnemidophorus (gularis, grahamii (= tesselatus), perplexus (= ?), tesselatus (= tigris) and sexlineatus). Only the latter are present in C. burti.

219. Taylor, H. L. 1965. Morphological variation in selected populations of the teiid lizards Cnemidophorus velox and Cnemidophorus inornatus. UNIV. COLORADO STUDIES, SERIES IN BIOLOGY No. 21: 1-27.

The morphology, color and pattern of both species is described in detail. Morphometric comparisons are made; each species exceeds the other in the variability of certain characters. C. inornatus is, in general, the more variable of the two. The triploid parthenogenetic nature of C. velox suggests that intraspecific variability occurring through mutations is unlikely, and implies reorigination (multiple hybridization events). Morphological characters may diverge, converge, or both in areas of sympatry, depending on characters and samples examined. The habitat of 2 of the 3 zones of sympatry, both in New Mexico, is described; they appear to be ecotonal or disturbed in nature.

220. —. 1968. The occurrence of the Teiid lizard Cnemidophorus tigris marmoratus in Arizona. HERPETOLOGICA 24(2): 162-168.

Specimens reported here occur in a mapped hiatus for the species. This paper primarily pertains to previous works by Zweifel (1962) and Dessauer et al. (1962) on intergradation between two subspecies of this lizard.

221. —. and P. A. Medica. 1966. Natural hybridization of the bisexual Teiid lizard Cnemidophorus inornatus and the unisexual Cnemidophorus perplexus in southern New Mexico. UNIVERSITY OF COLORADO STUDIES, SERIES IN BIOLOGY No. 22: 1-9.

Cnemidophorus perplexus = C. neomexicanus. 2 out of over 100 lizards examined from Dona Ana County appear to be hybrids. They are compared in exhaustive morphological detail to samples of both presumed parental species from in and near the hybridization area.

222. —, J. M. Walker and P. A. Medica. 1967. Males of three normally parthenogenetic species of Teiid lizards (genus Cnemidophorus). COPEIA 1967(4): 737-743.

The males were found in triploid populations of Cnemidophorus exsanguis (New Mexico), C. tessellatus (Colorado, New Mexico) and C. velox (Colorado), so they are not significant in terms of possible

sexual reproduction within these parthenoforms. It is suggested that they were derived parthenogenetically rather than being of hybrid origin. The presence of males proves that vestiges of bisexuality are retained within these parthenospecies and their scarcity may indicate that the evolution of parthenogenesis has reached an advanced stage.

223. Tinkle, D. W. 1959. Observations on the lizards Cnemidophorus tigris, Cnemidophorus tessellatus and Crotaphytus wislizeni. SOUTHWESTERN NATURALIST 4(4): 195-200.

It is suggested that the disjunct distribution of C. tessellatus in the west Texas panhandle is due to competition with C. tigris or C. gularis, as suitable habitat is present. The absence of males of the species in museum collections is noted. Size distribution of specimens indicates that most will not reach reproductive maturity until their second spring after birth. C. tigris marmoratus appears to be extending its range east of the Pecos River and into the caprock area below the high plains of northwest Texas. Reproductive maturity for both sexes is not reached until the second spring after birth, and the size at maturity is significantly smaller than that for C. tessellatus.

224. Turner, F. B. and C. S. Gist. 1965. Influences of a thermonuclear cratering test on close-in populations of lizards. ECOLOGY 46 (6): 845-852.

Pre- and post-test densities of Cnemidophorus tigris are given for the blast which occurred on 6 July 1962. Descriptions of the habitat, nuclear device, physical damage and radiation dosages are given. Adults were exterminated to a distance of 4000 feet from ground zero. No changes attributable to the explosion were detected beyond 8500 feet. Eggs hatched following the test in areas where adults did not survive. Immediate mortality is attributed to blast effects, delayed mortality to the destruction of habitat. Cnemidophorus may be more susceptible to deleterious effects than Uta.

225. —, P. A. Medica, J. R. Lannom, Jr. and G. A. Hoddenbach. 1969. A demographic analysis of fenced populations of the whiptail lizard Cnemidophorus tigris in southern Nevada. SOUTHWESTERN NATURALIST 14(2): 189-201.

Spring densities ranged from 3 to 8 lizards per acre, biomass between 43-114 gms/acre. The sex ratio was 1:1. Minimal annual adult survival was 54-60%; life spans may be as great as 7 years. Most females laid only 1 clutch per year of 2-4 eggs. Sexual maturity was normally reached during an individual's 3rd year (2nd reproductive season). The correlation between reproductive events and population

size and structure is discussed.

226. Uzzell, T. 1970. Meiotic mechanisms of naturally occurring unisexual vertebrates. *AMERICAN NATURALIST* 104(939): 433-445.

Six proposed pathways of oogenesis for unisexual vertebrates are reviewed. All parthenogenetic Cnemidophorus probably (although only demonstrated for C. uniparens) form ova by suppressing cytokinesis at the last premeiotic mitosis, which is then followed by two meiotic divisions based on pseudobivalents rather than synapsed homologues. Although they are fixed heterozygotes (and thus possibly well buffered against environmental shifts), there is no evidence for great antiquity of any of the unisexual species. The addition of new genetic variation by mutation and the elimination of ill-adapted genomes by selection cannot result in sufficiently rapid evolution to enable them to survive as long as sexual species.

227. Vance, T. 1978. A field key to the whiptail lizards (genus Cnemidophorus). Part 1: The whiptails of the United States. *BULLETIN OF THE MARYLAND HERPETOLOGICAL SOCIETY* 14(1): 1-9.

The key will only identify specimens that are adults, alive or freshly killed, and for which collection sites are known. Tentative range maps are included which are stated to provide a reasonably accurate estimate for each taxon. Cnemidophorus dixonii is not recognized to occur in New Mexico; that population is retained as C. tessellatus.

228. Van Devender, T. and J. I. Mead. 1978. Early Holocene and late Pleistocene amphibians and reptiles in Sonoran Desert packrat middens. *COPEIA* 1978(3): 464-475.

Cnemidophorus cf. tigris and Cnemidophorus sp. (probably sonorae) were found. A biogeographical discussion is presented in which the restriction of desert faunas to Mexican refugia during glacial periods is not supported.

229. —. and R. D. Worthington. 1977. The herpetofauna of Howell's Ridge cave and the paleoecology of the northwestern Chihuahuan Desert. in *TRANSACTIONS OF THE SYMPOSIUM ON THE BIOLOGICAL RESOURCES OF THE CHIHUAHUAN DESERT REGION, UNITED STATES AND MEXICO*. Wauer, R. H. and D. H. Riskind, editors. National Park Service Transactions and Proceedings Series No. 3: 85-106.

The fauna includes Cnemidophorus cf. tigris and C. spp., and ex-

tends back to 11500 years B.P. Several species of Cnemidophorus (exsanguis, tesselatus, tigris and uniparens) are common in the present fauna of the area, but the genus is only moderately represented in the fossil fauna. The paleoecology and zoogeography of the region is discussed.

230. Vanzolini, P. E., J. W. Wright, C. J. Cole and O. Cuellar. 1978. Parthenogenetic lizards (4 letters). SCIENCE 201: 1152-1155.

The first three criticize Cuellar for ignoring data, misunderstanding and misrepresenting facts and discussions that overwhelmingly support the hybrid origin of parthenogenetic Cnemidophorus in favor of his own theory of the spontaneous occurrence of parthenogenesis in hybrids in areas devoid of the sexual species. Cuellar replies that he did not mean to question the hybrid origin of parthenoforms, only the assumption that parthenogenetic Cnemidophorus arose directly from hybridizations without some intervening step(s) and whether or not all hybridization events lead to successful parthenoforms. The possibility of clonal succession over evolutionary time, suggested by Cuellar, is discussed.

231. Vitt, L. J. 1977. Observations on clutch and egg size and evidence for multiple clutches in some lizards of the southwestern United States. HERPETOLOGICA 33(3): 333-338.

Data for 2 different populations of Cnemidophorus tigris indicate that larger females lay more and larger eggs than do smaller females. There is evidence for multiple clutches in both populations.

232. —. 1978. Caloric content of lizard and snake (Reptilia) eggs and bodies and the conversion of weight to caloric data. JOURNAL OF HERPETOLOGY 12(1): 65-72.

Data on caloric, ash and water content of eggs and bodies of Cnemidophorus tigris, C. inornatus, C. sonorae and C. uniparens are presented. Formulae for the conversion of all other data to caloric content and the application of such data to future lizard energetic studies are discussed.

233. —. and R. D. Ohmart. 1977. Ecology and reproduction of lower Colorado River lizards. II. Cnemidophorus tigris (Teiidae), with comparisons. HERPETOLOGICA 33(2): 223-234.

Data are presented for one activity season. The habitats with

the greatest density of vegetation had the greatest density of lizards. Daily activity periods became bimodal in the summer. Food data is summarized; individual lizards foraged at the base of vegetation and moved over a wide area. Seasonal differences in food items consumed correlated with seasonal differences in prey abundance. Roadrunners are a major predator of C. tigris. Breeding activities peaked in May and June; females produced eggs from late May until late August. Mean clutch size was 2.9 (1-5) and two clutches were produced. Fat body cycles for males, females, and immatures are discussed. The minimization of competition with sympatric lizard species (none of them teiids) by various means is discussed.

234. Walker, J. M. 1966. Morphological variation in the Teiid lizard Cnemidophorus gularis. PH.D. DISS., UNIV. OF COLORADO. 128 p.

Systematic problems in this and related species are discussed. 7 subspecies are recognized. Cnemidophorus gularis gularis ranges from southern Oklahoma through Texas (and part of New Mexico) and much of northeastern Mexico. A minimum of 4 moderately distinctive morphotypes are recognized within this area, but formal recognition is deferred until further field work elucidates any significance to this relationship (from abstract).

235. Werth, R. J. 1972. Lizard ecology: evidence of competition. TRANSACTIONS KANSAS ACADEMY OF SCIENCES 75(4): 283-300.

Cnemidophorus sexlineatus viridis and 3 other lizard species were studied in Ellis County, Kansas. The habitat consisted of artificial sand pits and surrounding areas. The vegetation is described; the dominant ground cover was Buchloe dactyloides. Data on home ranges, growth rates, and habitat preferences are given for each species. C. sexlineatus viridis did not exhibit a microhabitat preference. Burrows were utilized as seasonal refuges. Lizards of this species appeared later in the day but disappeared earlier in the season than the other 3 species. A behavioral incident suggesting a thermal sensitivity to rapid temperature changes (thermesthesia) in this species is described. Food items consumed by C. sexlineatus included orthopterans (28%), lepidopterans (20%), spiders (15%), and snails of the genus Vertigo (4%); diet overlapped broadly with the other lizard species. Home ranges averaged .03 acres, but this value is not very reliable because of the methods used in determining it. Growth and reproduction are discussed. The average clutch size of 2.8 was the lowest of the 4 species in this study, but C. sexlineatus was the most numerous in the area. The data presented indicate that C. sexlineatus holds a competitive edge in this situation, which could change as the habitat reverts to natural grassland.

236. **Wever, E. G.** 1967. The tectorial membrane of the lizard ear: species variations. *JOURNAL OF MORPHOLOGY* 123(4): 355-372.

A complete type of tectorial membrane is found in the lizard Cnemidophorus tessellatus. A photomicrograph of the inner ear is presented and a complete description of the tectorial membrane and its relation to other inner ear structures is given.

237. **Whitford, W. G. and F. M. Creusere.** 1977. Seasonal and yearly fluctuations in Chihuahuan Desert lizard communities. *HERPETOLOGICA* 33(1): 54-65.

Cnemidophorus exsanguis, C. inornatus, C. tessellatus and C. tigris marmoratus were part of a community studied in 4 habitat types of a Chihuahuan Desert watershed. C. tessellatus and C. tigris were permanent residents of open Larrea and yucca-mesquite-Ephedra habitats and transients in playa grassland habitat and arroyo shrub associations. C. exsanguis was an immigrant from montane habitats into playa grassland and yucca-mesquite-Ephedra habitats, as was C. inornatus, which was also present as a transient resident. Cnemidophorus tigris populations fluctuated markedly, showing a doubling in density in certain years. Increased rainfall and food availability resulted in larger clutch sizes, increased survivorship of hatchlings and recruitment of young into the population. Playa and bajada populations exhibited some seasonal cyclic differences; bajada population levels also tended to fall more quickly after an opportunistic increase. Cnemidophorus tessellatus populations, however, exhibited very little fluctuation in densities over the 5 years encompassed by this study, remaining at all times at a much lower level than those of C. tigris. Adults and hatchlings of both species exhibited varying degrees of allochronic seasonal activity based on food availability and abundance. The playa acts as a "cold-air sink", delaying spring emergence of lizards 3-4 weeks behind those on the bajada. Overall lizard species diversity for a given year was correlated with the previous 2 years rainfall.

238. **Wiley, E. O.** 1978. The evolutionary species concept reconsidered. *SYSTEMATIC ZOOLOGY* 27(1): 17-26.

Problems concerning the use of the species concept in different ways by biologists with diverging viewpoints (i.e. ecologists and evolutionists) are discussed. Simpson's definition of the 'evolutionary species' is modified to "a species is a lineage of ancestral-descendant populations which maintains its identity from other such lineages and which has its own evolutionary tendencies and historical fate". The application of the evolutionary species concept to allopatric demes and to asexual species is discussed. It is concluded that the lack of evolutionary divergence forms the basis for grouping such populations into single species (i.e. all C. tessellatus clones belong to a single spe-

cies). It is suggested that some ecological species definitions lead to underestimations of the rate of extinction due to interspecific competition because their logical frameworks exclude unsuccessful species from being considered species.

239. Willard, D. E. 1966. The thermoeology of Cnemidophorus tigris. PH.D. DISSERTATION, UNIVERSITY OF CALIFORNIA-DAVIS. 99 p.

A population in central California was studied for three years. Lizard body temperatures were closely correlated with substrate temperatures. Body temperatures of active lizards ranged from 33 to 41°C. The mean body temperature of juveniles is lower than that of adults. Seasonal activity is bimodal. The thermal characteristics of microhabitats lizards utilized were measured and correlated with lizard activity over the study period: the first year was optimal, the second too hot and the third too cold. C. tigris was more active, abundant and enjoyed higher reproductive success over the first year than over the other two. Emergence and retreat depend upon favorable thermal microhabitats and releasing subsurface temperatures of 30-33°C. Lower reproductive success was caused by high temperatures reducing favorable egg deposition sites and intraspecific interference with foraging activities during shortened activity seasons (from abstract).

240. Williams, K. L. 1960. Taxonomic notes on Arizona herpetozoa. SOUTHWESTERN NATURALIST 5(1): 25-36.

Some morphological characteristics for Cnemidophorus burti stictogrammus are given. A review of diagnostic characters of C. tigris gracilis and C. tigris septentrionalis is presented and range maps (now obsolete) given.

241. —, H. M. Smith and P. S. Chapliwy. 1960. Turtles and lizards from northern Mexico. TRANS. ILLINOIS ST. ACAD. SCI. 53(1&2): 36-45.

Cnemidophorus tessellatus was collected along the Rio Florida in northern Chihuahua in vegetation of willows, cottonwoods, and fairly heavy undergrowth. C. tigris marmoratus was collected from the same vicinity.

242. Wright, J. W. 1963. Cnemidophorus gularis in New Mexico. SOUTHWESTERN NATURALIST 8(1): 56.

Two specimens from the state are reported. The systematic uncertainty regarding this taxon as it pertains to confusion over the occur-

range of this species in New Mexico is reviewed.

243. —. 1966. Variation in two sympatric whiptail lizards (Cnemidophorus inornatus and C. velox) in New Mexico. SOUTHWESTERN NATURALIST 11(1): 54-71.

These lizards are reported as sympatric sibling species in New Mexico. The nomenclatural history of each is reviewed. Morphological characteristics are compared; north-south oriented clines are present in both species. Distinguishing features are given for both species. Marked ecological differences were found: C. velox is primarily an inhabitant of oak-mountain mahogany and pinyon-juniper associations with little or no grass cover whereas C. inornatus inhabits primarily grassland associations whether primary or overgrazed and replaced by pioneer invaders.

244. —. 1968. Variation in 3 sympatric sibling species of whiptail lizards (genus Cnemidophorus). J. OF HERPETOLOGY 1(1/4): 1-20.

Specific relationships between Cnemidophorus inornatus, C. uniparens and C. velox are examined. Variation in meristic characters from sympatric populations of at least 2 of the species in Arizona, New Mexico and Chihuahua is discussed. Geographic and ecological characteristics of the 3 species are discussed with particular emphasis on areas of sympatry. Four specimens representing possible hybrids between C. inornatus and C. uniparens are examined. It is concluded that the 3 forms discussed are readily distinguishable on the species level and a key is provided.

245. —. 1969. Status of the name Cnemidophorus perplexus Baird and Girard (Teiidae). HERPETOLOGICA 25(1): 67-69.

The history of application of the name is reviewed, and a recommendation of complete removal of the name from availability within the genus is made.

246. —. 1971. Cnemidophorus neomexicanus. CATALOGUE OF AMERICAN AMPHIBIANS AND REPTILES: 109.1-109.3

A summary of information on the species, including a bibliography and range map, is provided. The major part of the species' distribution is on sandy soils within the Rio Grande floodplain, where periodic flooding maintains perpetually disturbed situations. It can also be found at the edges of playas, sandy arroyos and washes, and in other

open sandy habitats.

247. —. and W. G. Degenhardt. 1962. The type locality of Cnemidophorus perplexus. COPEIA 1962(1): 210-211.

The type locality in Sandoval County, New Mexico, is determined through historical accounts. The area is revisited and specimens referable to the taxon collected. The ecological history of the area is discussed, and a map is provided. (NOTE: C. perplexus implies C. neomexicanus but is not synonymous with it. See Lowe and Wright (1966) and Wright and Lowe (1967b)).

248. —. and C. H. Lowe. 1965. The rediscovery of Cnemidophorus arizonae Van Denburgh. J. ARIZONA ACADEMY OF SCIENCES 3: 164-168.

The taxonomic history of the name Cnemidophorus arizonae Van Denburgh is discussed, and the lizard known by this name is formally referred to Cnemidophorus inornatus arizonae. The new species Cnemidophorus uniparens is also formally recognized. Both taxa are described, diagnosed and compared with other taxa within the genus, and their geographic distributions are given.

249. —. and —. 1967a. Evolution of the allopolyploid parthenospecies Cnemidophorus tessellatus (Say). MAMMALIAN CHROMOSOMES NEWSLETTER 8(2): 95-96.

The hybridization steps yielding diploid and triploid clones of this parthenoform from C. tigris, C. septemvittatus and C. sexlineatus are outlined.

250. —. and —. 1967b. Hybridization in nature between parthenogenetic and bisexual species of whiptail lizards (genus Cnemidophorus). AMERICAN MUSEUM NOVITATES No. 2286: 1-36.

Six morphologically aberrant specimens of Cnemidophorus taken from 3 localities in New Mexico represent hybrids between the sexual species C. inornatus and the parthenospecies C. neomexicanus. They are morphologically identical to the type specimen of C. perplexus Baird and Girard, and differ in the same aberrant ways from C. neomexicanus. They carry a triploid chromosome complement of 69, consisting of the diploid complement of 46 from the parthenospecies and a haploid complement of 23 from the paternal sexual species. The total hybrid sample of 7 consists of 3 males and 4 females. A detailed morphological analysis of the hybrids and samples of the parental species from

points of sympatric hybridization was made. The overall hybrid index for the 11 characters analyzed places the hybrids exactly intermediate between the parental forms; the hybrids resemble one or the other parent more closely when individual characters are considered. Thus C. perplexus represents an unsuccessful hybridization event in this genus spanning a period of over 100 years. The three hybrid localities (8.4 mi. W. of Hatch, Dona Ana Co; 9 mi. E. of La Joya, Socorro Co; San Pedro Creek and Tanque Arroyo, Sandoval Co.) exhibit disturbed or ecotonal habitats. A fourth hybrid locality mentioned but not reported on here is in the vicinity of Mesilla, Dona Ana County.

251. —. and —. 1968. Weeds, polyploids, parthenogenesis and the geographical and ecological distribution of all-female species of Cnemidophorus. COPEIA 1968(1): 128-137.

The parthenospecies exsanguis, flagellicaudus, neomexicanus, sonorae, tesselatus, uniparens and velox are each ecologically characterized. The primary center of distribution of these forms is the North American southwest adjacent to the Continental Divide and the area of confluence between the Rocky Mountains and the Mexican Plateau. The habitats occupied by the various species are diverse but can be defined as "weed habitats". The presence of such habitats at the time of origin of parthenogenetic individuals from hybridization between bisexual species is a critical factor and the features that contribute to the perpetuation of the parthenospecies are discussed.

252. Yousef, I. M., W. G. Bradley and M. K. Yousef. 1977. Bile acid composition of some lizards from the southwestern United States. PROCEEDINGS SOC. EXPERIMENTAL BIOLOGY AND MEDICINE 154(1): 22-26.

Nine species from Nevada, including Cnemidophorus tigris, were studied. At least 6 different acids were present in this species, with cholic acid being the primary one. Teiids and Gekkonids had very similar compositions.

253. Zweifel, R. G. 1958. Cnemidophorus tigris variolosus, a revived subspecies of whiptail lizard from Mexico. SOUTHWEST. NAT. 3: 94-101.

Morphological and distributional attributes of Cnemidophorus tigris marmoratus are discussed.

254. —. 1962. Analysis of hybridization between two subspecies of the Desert Whiptail lizard, Cnemidophorus tigris. COPEIA 1962: 749-66.

Fertile hybrids between C. t. gracilis and C. t. marmoratus are described from an area 45 by 65 miles centered on the northern Animas Valley in southwestern New Mexico. Evidence for hybridization is based on color and scutellation characteristics. The ecological distribution of the two subspecies within the study area is described. Hybrids are known from 3 areas; Granite Gap and Steins in the Peloncillo Mountains and in the vicinity of Redrock. The hybrid zone in the Peloncillos is only about one mile wide. Historical factors presumed to influence the described phenomenon are discussed. It is suggested that the two subspecies came into contact during post-Wisconsin times due to the establishment of a desert corridor across the Continental Divide along with expansion of the two taxa from glacial refugia. They are so similar in habitat requirements and adaptations that neither is replaced by the other. Hybrids are produced because of the absence of reproductive isolating mechanisms but hybrid gene combinations are selectively disadvantageous compared to pure parental types.

255. —. 1965. Variation in and distribution of the unisexual lizard, Cnemidophorus tessellatus. AMERICAN MUS. NOVITATES 2235: 1-49.

This is the classic paper on the species. Its unisexual nature is confirmed, and individual and geographic morphological variation is described in detail. A range map is given. Six pattern classes are described, with greater amounts of ontogenetic change in pattern occurring from class A through class F. Pattern classes C and D occur in northeastern New Mexico, sometimes sympatrically, northeast of the Pecos River. Pattern class E occurs throughout the rest of the state, except for two isolated populations in Hidalgo County which are referable to pattern class F. There are places throughout the range of E, for instance Socorro County, where adjacent populations are morphologically different. The existence of multiple clones is suggested. No geographic trends are apparent; variation appears to be random. Variation in 3 scale characters tends to separate classes A-D from E and F. The most striking feature of variation is the relative homogeneity of lizards of class E (geographically the most widespread class) and the diversity of populations occupying the minor remaining part of the species range. C. tessellatus shows ranges of variation in pattern and scutellation quite similar to those of widely distributed sexual species of the genus. When samples from restricted areas are compared, however, tessellatus usually exhibits much less variation than the sexual C. tigris.

Patterns of evolution in C. tessellatus are discussed. The apparent absence of multiple clones in most local populations is attributed to low mutation rates and/or strong selection for the best-adapted clones to local conditions. Advantages of parthenogenetic reproduction include a higher intrinsic populational rate of increase compared with a similarly structured sexual population. A parthenogenetic population consisting of one or a few similar clones that were particularly well-adapted to existing conditions might have an advantage over a sexual population that, in effect, sacrificed some of its offspring in

more frequent deleterious gene recombinations. But if the parthenogen could not respond quickly enough by genetic adaptation to changing environmental conditions, the population might be at a disadvantage compared to a sexual one able more readily to draw upon stored genetic variation. It is suggested that parthenogenetic populations may depend upon, and be able to tolerate, greater mutational rates than sexual populations. There is no evidence that parthenogenetic Cnemidophorus exhibit a wider ecological valence than sexual species, which could compensate for lower populational potential for genetic change. Pattern type relationships indicate that C. tessellatus spread from north to south whereas paleoclimatic data indicate just the opposite. The northern part of the species range must have been occupied by it after the termination of Wisconsin glaciation. It is suggested that tessellatus is closely related to C. tigris or C. septemvittatus, or some other species in the tigris-sexlineatus complex.

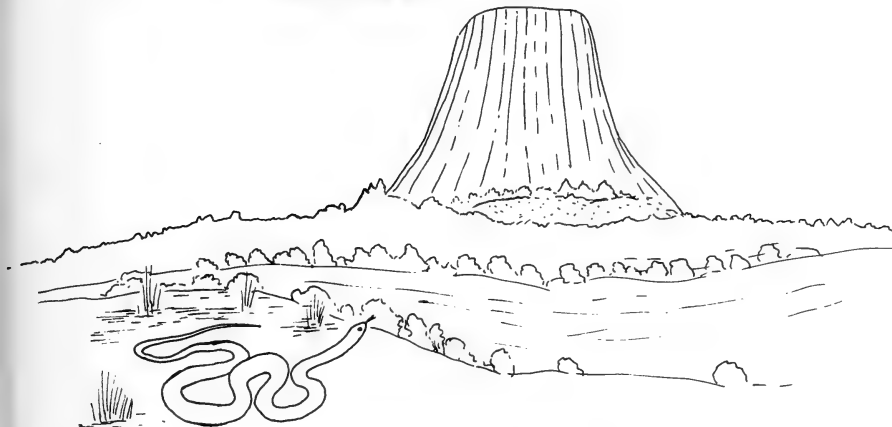
Difficulties in the taxonomic treatment of parthenospecies are briefly discussed. It is suggested that the most reasonable taxonomic choice is to group all of the populations of C. tessellatus into one species; this emphasizes their presumed close relationship and common ancestry. Lizards found at the type locality today belong to class A (which is now known to be triploid) whereas the description of the type material collected in 1820 is of lizards belonging to class D (which is diploid). The closest approach of class D to the type locality today is 70 airline miles to the southeast, and class B (triploid) occupies the intervening area. A diagnosis of C. tessellatus is provided. Habitat is discussed briefly but not well defined. The species is usually but not always found on rocky soils and in roughland habitats from 1500 to 5500 feet in elevation. Its distribution is spotty throughout its range and appears to be riparian to a great extent. The habitat of the isolated population in Antelope Pass, Hidalgo County, New Mexico, is described in more detail. It inhabits a sandy desert wash dominated by mesquite and desert willow.





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SELECTED BIBLIOGRAPHY OF WYOMING
AMPHIBIANS AND REPTILES



PAUL STEPHEN CORN, R. BRUCE BURY
& HARTWELL H. WELSH

Denver Wildlife Research Center
U.S. Fish and Wildlife Service

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INTRODUCTION

This bibliography is composed of literature citations on the amphibians and reptiles of Wyoming that were part of the Wildlife Species Data Base (MANAGE), prepared in 1980 in cooperation with the Office of Biological Services (OBS), U.S. Fish and Wildlife Service. The list of references has since been updated to include papers published through September 1982. We feel that an organized compilation of this information will be useful to both researchers and managers, and can be used as reference material in faunal resource assessment, evaluation of impacts, resource development, critical habitat determination, and endangered species listing. The need for these activities was underscored by the recent probable extinction of a zoogeographically important species (Bufo hemiophrys) in Wyoming (Baxter and Meyer, 1982).

The ecological literature on amphibians and reptiles is spotty; only a few species have been relatively well studied. For most species, particularly those that have cryptic life styles or occur in low densities, basic life history data are nonexistent or have been published in largely anecdotal form. Given the initial paucity of the herpetological literature, the problems are compounded when compiling references that pertain to Wyoming populations. The most recent treatment of the Wyoming herpetofauna is that of Baxter and Stone (1980), who listed 94 references. The majority of these do not pertain specifically to Wyoming populations.

References for the MANAGE data base were compiled in a hierarchical manner. Studies on Wyoming populations were given first priority. Studies from habitats similar to those in Wyoming were given nearly equal weight. Where these types of studies were not available, general natural history information that was generally applicable to the species was used. The result is a list of 353 references. Of these, only 49 represent studies performed on Wyoming populations.

Literature citations for each species are arranged according to 10 selected topics: taxonomy, distribution, economic and legal status, population characteristics, habitat utilization, feeding, breeding, space use and temporal activity, effects of habitat modification, and other. The last category includes references of secondary interest and was used infrequently in the amphibian and reptile accounts.

The list of Wyoming species was taken from Baxter (1947) and Baxter and Stone (1980). Thirty-four species are included: one salamander, 11 frogs and toads, four turtles, seven lizards, and 11 snakes. Subspecies are not treated separately. In view of the inadequacy of the literature for most species and the small number of species where more than one race occurs in the state, we consider this decision justified. The one possible exception is the lizard Sceloporus undulatus. Three races with rather distinct ecologies occur in Wyoming. Although it is not possible to tell from the literature citations alone, we attempted (within the limits of the format) to differentiate between the races in the MANAGE account for this species. Scientific and common names used in this report follow Collins et al. (1978).

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AMPHIBIANS AND REPTILES OF WYOMING

Amphibia

Urodela

Ambystoma tigrinum (Tiger Salamander)

Anura

Bufo boreas (Boreal Toad)Bufo cognatus (Great Plains Toad)Bufo hemiophrys (Wyoming Toad)Bufo woodhousei (Woodhouse's Toad)Pseudacris triseriata (Boreal Chorus Frog)Rana catesbeiana (Bullfrog)Rana pipiens (Northern Leopard Frog)Rana pretiosa (Spotted Frog)Rana sylvatica (Wood Frog)Scaphiopus bombifrons (Plains Spadefoot Toad)Scaphiopus intermontanus (Great Basin Spadefoot Toad)

Reptilia

Testudines

Chelydra serpentina (Common Snapping Turtle)Chrysemys picta (Western Painted Turtle)Terrapene ornata (Ornate Box Turtle)Trionyx spiniferus (Western Spiny Softshell Turtle)

Sauria

Cnemidophorus sexlineatus (Prairie-lined Racerunner)Eumeces multivirgatus (Northern Many-lined Skink)Holbrookia maculata (Northern Earless Lizard)Phrynosoma douglassi (Eastern Short-horned Lizard)Sceloporus graciosus (Sagebrush Lizard)Sceloporus undulatus (Eastern Fence Lizard)Urosaurus ornatus (Northern Tree Lizard)

Serpentes

Charina bottae (Rubber Boa)Coluber constrictor (Racer)Crotalus viridis (Western Rattlesnake)Heterodon nasicus (Plains Hognose Snake)Lampropeltis triangulum (Milk Snake)Opheodrys vernalis (Smooth Green Snake)Pituophis melanoleucus (Bull Snake)Storeria occipitomaculata (Black Hills Redbelly Snake)Thamnophis elegans (Wandering Garter Snake)Thamnophis radix (Western Plains Garter Snake)Thamnophis sirtalis (Common Garter Snake)

SPECIES ACCOUNTS

Amphibians

Urodela

Ambystoma tigrinum Tiger Salamander

- Taxonomy: Gehlbach 1967; Reese 1972; Collins et al. 1978; Baxter and Stone 1980; Collins et al. 1980; Pierce and Mitton 1980.
- Distribution: Baxter 1947; Gehlbach 1967; Conant 1975; Bury et al. 1978; Baxter and Stone 1980.
- Economic and legal status: Bury et al. 1978.
- Population characteristics: Wyoming Game and Fish Dept. 1977; Baxter and Stone 1980.
- Habitat utilization: Blair 1951; Stebbins 1951; Carpenter 1953; Beidleman 1954; Pennak 1969; Tanner et al. 1971; Peterson 1974; Sexton and Bizer 1978; Sharp 1979; Baxter and Stone 1980; Hammerson and Langlois 1981.
- Feeding: Stebbins 1951; Moore and Strickland 1955; Dodson and Dodson 1971; Olenick and McGee 1981.
- Breeding: Collins 1974; Sexton and Bizer 1977; Baxter and Stone 1980.
- Space use and temporal activity: Stebbins 1951; Baxter and Stone 1980; Campbell and Clark 1981.
- Effects of habitat modification and management: Wassersug and Siebert 1975; Olenick and McGee 1981.

Anura

Bufo boreas Boreal Toad

- Taxonomy: Collins et al. 1978.
- Distribution: Baxter 1947; Stebbins 1966; Campbell 1970b; Baxter and Stone 1980.
- Economic and legal status: None
- Population characteristics: Wyoming Game and Fish Dept. 1977; Baxter and Stone 1980.
- Habitat utilization: Blair 1951; Stebbins 1951; Carpenter 1953; Campbell 1970b, 1970c; Black and Brunson 1971; Campbell and Degenhardt 1971; Baxter and Stone 1980; Hammerson and Langlois 1981.
- Feeding: Campbell 1970a; Altig and Kelly 1974; Wassersug 1975; Miller 1978.
- Breeding: Stebbins 1951; Campbell 1972; Baxter and Stone 1980.
- Space use and temporal activity: Campbell 1970a, 1970c; Baxter and Stone 1980; Beiswenger 1981; Campbell and Clark 1981.
- Effects of habitat modification and management: Mulla et al. 1963; Mulla 1966; Johnson and Prine 1976; Porter and Hakanson 1976.

Bufo cognatus Great Plains Toad

Taxonomy: Bragg 1940; Collins et al. 1978.
 Distribution: Conant 1975; Bury et al. 1978; Baxter and Stone 1980.
 Economic and legal status: Bragg 1943; Bury et al. 1978.
 Population characteristics: Wyoming Game and Fish Dept. 1977; Sharp 1979; Baxter and Stone 1980.
 Habitat utilization: Bragg 1937, 1940; Stebbins 1951; Sharp 1979; Baxter and Stone 1980; Hammerson and Langlois 1981.
 Feeding: Bragg 1940; Smith and Bragg 1949.
 Breeding: Bragg 1937a, 1937b, 1940; Stebbins 1951.
 Space use and temporal activity: Bragg 1937a, 1940; Stebbins 1951.
 Effects of habitat modification and management: Bragg 1940.

Bufo hemiophrys Wyoming Toad

Taxonomy: Porter 1958; Packard 1971; Collins et al. 1978.
 Distribution: Porter 1968; Conant 1975; Bury et al. 1978; Baxter and Stone 1980.
 Economic and legal status: Bury et al. 1978.
 Population characteristics: Wyoming Game and Fish Dept. 1977; Baxter and Stone 1980; Stromberg 1981; Baxter and Meyer 1982.
 Habitat utilization: Baxter 1949; Stebbins 1951, 1966; Breckenridge and Tester 1961; Tester and Breckenridge 1964; Porter 1968; Baxter and Stone 1980.
 Feeding: Moore and Strickland 1954; Altig and Kelly 1974; Wassersug 1975.
 Breeding: Breckenridge and Tester 1961; Baxter and Stone 1980.
 Space use and temporal activity: Breckenridge and Tester 1961; Porter 1968.
 Effects of habitat modification and management: Tester et al. 1965; Barclay 1980; Baxter and Stone 1980; Baxter and Meyer 1982.

Bufo woodhousei Woodhouse's Toad

Taxonomy: Collins et al. 1978.
 Distribution: Baxter 1947; Conant 1975; Bury et al. 1978; Baxter and Stone 1980.
 Economic and legal status: Bragg 1943; Bury et al. 1978.
 Population characteristics: Baxter and Stone 1980.
 Habitat utilization: Bragg 1940; Stebbins 1951; Underhill 1960; Black 1970a; Peterson 1974; Baxter and Stone 1980; Hammerson and Langlois 1981.
 Feeding: Bragg 1940; Smith and Bragg 1949; Stebbins 1951; Gehlbach and Collette 1959; Altig and Kelly 1974; Seale and Beckvar 1980.
 Breeding: Bragg 1940; Stebbins 1951; Underhill 1960.
 Space use and temporal activity: Bragg 1940; Stebbins 1951.
 Effects of habitat modification and management: Ferguson and Gilbert 1967; Sanders 1970; Wassersug and Siebert 1975; Porter and Hakanson 1976; Sharp 1979; Barclay 1980.

Pseudacris triseriata Boreal Chorus Frog

- Taxonomy: Smith 1956; Whitaker 1971; Collins et al. 1978.
 Distribution: Baxter 1947; Spencer 1971; Conant 1975; Bury et al. 1978; Baxter and Stone 1980.
 Economic and legal status: Bury et al. 1978.
 Population characteristics: Smith 1961; Spencer 1964 Miller 1977; Wyoming Game and Fish Dept. 1977.
 Habitat utilization: Baxter 1949; Blair 1951; Stebbins 1951; Carpenter 1953a 1953b; Spencer 1964, 1971; Pettus and Spencer 1964; Hess 1969; Matthews 1971; Whitaker 1971; Peterson 1974; Miller 1977; Behler and King 1979; Sharp 1979; Baxter and Stone 1980; Hammerson and Langlois 1981.
 Feeding: Moore and Strickland 1954; Whitaker 1971; Altig and Kelly 1974; Christian 1976, 1982.
 Breeding: Spencer 1964; Pettus and Angleton 1967; Hess 1969; Miller 1977; Baxter and Stone 1980; Corn 1980.
 Space use and temporal activity: Spencer 1964; Whitaker 1971; Kramer 1973, 1974; Miller 1977; Campbell and Clark 1981.
 Effects of habitat modification and management: Gosner and Black 1957; Hess 1969; Sanders 1970; Wassersug and Siebert 1975; Porter and Hakanson 1976; Barclay 1980.

Rana catesbeiana Bullfrog

- Taxonomy: Collins et al. 1978.
 Distribution: Baxter 1947; Conant 1975; Baxter and Stone 1980.
 Economic and legal status: Dumas 1966; Black 1970; Moyle 1973; Bury et al. 1978.
 Population characteristics: Bury 1976a; Wyoming Game and Fish Dept. 1977; Baxter and Stone 1980.
 Habitat utilization: Stebbins 1951; Willis et al. 1956; Gosner and Black 1957; Bury 1976a; Howard 1978a, 1978b; Tyler and Hoestenbach 1979; Baxter and Stone 1980; Hammerson and Langlois 1981.
 Feeding: Stebbins 1951; Carpenter and Morrison 1973; Bury 1976a; Tyler and Hoestenbach 1979; Bruneau and Magnin 1980b; Seale and Beckvar 1980.
 Breeding: Willis et al. 1956; Viparina and Just 1975; Bury 1976a; Howard 1978b; Baxter and Stone 1980; Bruneau and Magnin 1980a, 1980b.
 Space use and temporal activity: Emlen 1968; Currie and Bellis 1969; Carpenter and Morrison 1973; Bury 1976a; Howard 1978b.
 Effects of habitat modification and management: Wilbur 1954; Gosner and Black 1957; Ferguson 1963; Mulla 1963; Mulla et al. 1963; Mulla 1966; Mulla et al. 1966; Meeks 1968; Dimond et al. 1975; Treanor 1975; Weis 1975; Bury 1976a; Barclay 1980; Hall and Kolb 1980.

Rana pipiens Northern Leopard Frog

- Taxonomy: Brown 1973; Pace 1974; Gillis 1975; Dunlap and Kruse 1976; Collins et al. 1978; Lynch 1978; Dunlap and Platz 1981.
- Distribution: Baxter 1947; Stebbins 1974; Smith 1963c; Conant 1975; Bury et al. 1978; Baxter and Stone 1980.
- Economic and legal status: Gibbs et al. 1971; Bury et al. 1978.
- Population characteristics: Stebbins 1951; Dole 1965a; Gibbs et al. 1971; Merrell 1977; Wyoming Game and Fish Dept. 1977; Sharp 1979; Baxter and Stone 1980.
- Habitat utilization: Baxter 1947; Wright and Wright 1949; Stebbins 1951, 1954; Maslin 1964; Pennak 1969; Emery et al. 1972; Peterson 1974; Merrell 1977; Lynch 1978; Sharp 1979; Baxter and Stone 1980; Hammerson and Langlois 1981; Livo 1981; Corn 1982.
- Feeding: Knowlton 1944; Stebbins 1951; Gehlbach and Collette 1959; Linzey 1967; Dickman 1968; Hendricks 1973; Wassersug 1975.
- Breeding: Baxter 1949, 1952; Stebbins 1951; Merrell 1977; Baxter and Stone 1980; Corn 1981, 1982; Livo 1981.
- Space use and temporal activity: Stebbins 1951; Dole 1965a, 1965b; Merrell 1977; Campbell and Clark 1981; Livo 1981.
- Effects of habitat modification and management: Helff and Stubblefield, 1931; Stebbins 1951; Kaplan and Yoh 1961; Ferguson 1963; Kaplan and Overpeck 1964; Meeks 1968; Lande and Guttman 1973; Dimond et al. 1975; Wassersug and Siebert 1975; Merrell 1977; Punzo et al. 1979; Barclay 1980; Noland and Utsch 1981.

Rana pretiosa Spotted Frog

- Taxonomy: Thompson 1913; Stebbins 1954; Dumas 1966; Turner and Dumas 1972; Collins et al. 1978.
- Distribution: Baxter 1947; Stebbins 1966; Turner and Dumas 1972; Dunlap 1977; Baxter and Stone 1980.
- Effects of habitat modification and management: Baxter and Stone 1980.
- Population characteristics: Stebbins 1951; Turner 1958; Wyoming Game and Fish Dept. 1977; Baxter and Stone 1980.
- Habitat utilization: Stebbins 1951; Carpenter 1954; Middendorf 1957; Turner 1958, 1960; Licht 1969, 1971; Baxter and Stone 1980.
- Feeding: Stebbins 1951; Moore and Strickland 1955; Turner 1959; Dickman 1968; Wassersug 1975.
- Breeding: Turner 1958, 1960.
- Space use and temporal activity: Turner 1958, 1960; Licht 1969, 1971.
- Effects of habitat modification and management: Turner 1960; Barclay 1980.

Rana sylvatica Wood Frog

- Taxonomy: Martof and Humphries 1959; Porter 1969a, 1969b; Martof 1970; Packard 1971; Bagdonas and Pettus 1976; Collins et al. 1978.
- Distribution: Baxter 1947; Stebbins 1954; Porter 1969b; Martof 1970; Conant 1975; Bagdonas and Pettus 1976; Dunlap 1977; Baxter and Stone 1980.

Economic and legal status: Bury et al. 1978.
 Population characteristics: Heatwole 1961; Bagdonas 1968; 1971; Wyoming Game and Fish Dept. 1977; Anderson 1978; Baxter and Stone 1980; Haynes and Aird 1981.
 Habitat utilization: Maslin 1947; Stebbins 1951; Bellis 1961a, 1965; Heatwole 1961; Bagdonas 1968, 1971; Anderson 1978; Baxter and Stone 1980; Hammerson and Langlois 1981; Haynes and Aird 1981; Seale 1982.
 Feeding: Stebbins 1951; Moore and Strickland 1955; Dickman 1968; Wassersug 1975; Seale and Beckvar 1980.
 Breeding: Stebbins 1951; Bellis 1961b; Bagdonas 1968; Baxter and Stone 1980; Haynes and Aird 1981; Seale 1982.
 Space use and temporal activity: Heatwole 1961; Bellis 1962, 1965; Seale 1982.
 Effects of habitat modification and management: Fashingbauer 1957; Gosner and Black 1957; Bagdonas 1971; Anderson 1978; Haynes and Aird 1981.

Scaphiopus bombifrons Plains Spadefoot Toad

Taxonomy: Tanner 1939; Northen 1970; Collins et al. 1978; Sattler 1980.
 Distribution: Baxter 1947; Chrapliwy and Findley 1956; Northen 1970; Bury et al. 1978; Baxter and Stone 1980.
 Economic and legal status: Bury et al. 1978.
 Population characteristics: Stebbins 1951; Wyoming Game and Fish Dept. 1977; Baxter and Stone 1980.
 Habitat utilization: Gilmore 1924; Stebbins 1951; Chrapliwy and Findley 1956; Woody and Thomas 1966; Black 1970a; Collins 1974; Baxter and Stone 1980; Hammerson and Langlois 1981.
 Feeding: Gilmore 1924; Stebbins 1951; Bragg 1956; Bragg and Bragg 1958.
 Breeding: Voss 1961; Woody and Thomas 1966; Black 1970a; Collins 1974; Baxter and Stone 1980.
 Space use and temporal activity: Baxter and Stone 1980.
 Effects of habitat modification and management: Wassersug and Siebert 1975.

Scaphiopus intermontanus Great Basin Spadefoot Toad

Taxonomy: Tanner 1939; Northen 1970; Collins et al. 1978.
 Distribution: Tanner 1939; Baxter 1947; Stebbins 1966; Northen 1970; Baxter and Stone 1980.
 Economic and legal status: none
 Population characteristics: Stebbins 1951; Baxter and Stone 1980.
 Habitat utilization: Tanner 1939; Baxter 1948; Wright and Wright 1949; Stebbins 1951; Baxter and Stone 1980; Hammerson and Langlois 1981.
 Feeding: Wright and Wright 1949; Stebbins 1951; Acker and Larson 1979.
 Breeding: Baxter 1948; Baxter and Stone 1980.
 Space use and temporal activity: Baxter and Stone 1980.
 Effects of habitat modification and management: none

Reptiles

Testudines

Chelydra serpentina Common Snapping Turtle

Taxonomy: Collins et al. 1978; Baxter and Stone 1980.

Distribution: Ernst and Barbour 1972; Sharp 1979; Baxter and Stone 1980.

Economic and legal status: Baxter and Stone 1980.

Population characteristics: Carr 1952; Ernst and Barbour 1972; Froom 1976; Baxter and Stone 1980.

Habitat utilization: Carr 1952; Ernst and Barbour 1972; Collins 1974; Baxter and Stone 1980; Obbard and Brooks 1980; Schuett and Gatten 1980; Hammerson and Langlois 1981; Obbard and Brooks 1981.

Feeding: Pell 1940; Lagler 1943; Darrow 1963; Wheeler and Wheeler 1966; Hammer 1969; Hudson 1972; Punzo 1975; Baxter and Stone 1980.

Breeding: Carr 1952; Hammer 1969, 1971a 1971b; Black 1970b; Yntema 1970, 1978; Punzo 1975; Christiansen and Burken 1979.

Space use and temporal activity: Ernst 1968; Gibbons and Smith 1968; Hammer 1969; Obbard and Brooks 1981.

Effects of habitat modification and management: Maslin 1964; Gibbons 1968; Meeks 1968; Hammer 1969; Ernst and Barbour 1972; Collins 1974; Jackson et al. 1974; Punzo et al. 1979; Barclay 1980.

Other: Timken 1968; Stone 1976.

Chrysemys picta Western painted turtle

Taxonomy: Ernst 1971a; Ernst and Barbour 1972; Ernst and Ernst 1980; Vogt and McCoy 1980.

Distribution: Maslin 1959; Ernst 1971a; Baxter and Stone 1980.

Economic and legal status: Lagler 1943.

Population characteristics: Sexton 1959; Meseth and Sexton 1963; Ernst and Barbour 1972; Bury 1976b; McAuliffe 1978; Baxter and Stone 1980.

Habitat utilization: Sexton 1959; Meseth and Sexton 1963; Wheeler and Wheeler 1966; Gibbons 1967; Bury 1976b; Bury et al. 1979; Baxter and Stone 1980; Hammerson and Langlois 1981.

Feeding: Raney and Lachner 1942; Lagler 1943; Darrow 1963; Gibbons 1967; Clark and Gibbons 1969; Bury 1976b.

Breeding: Ernst and Barbour 1972; Christiansen and Moll 1973; Moll 1973; Snow 1980; Tinkle et al. 1981.

Space use and temporal activity: Cahn 1937; Ernst 1971b; Bury 1976b; Bury et al. 1979.

Effects of habitat modification and management: Gibbons 1967; Meeks 1968; Ernst and Barbour 1972; Bury 1976b; Owen and Wells 1976; Punzo et al. 1979; Barclay 1980.

Other: Timken 1968.

Terrapene ornata Ornate Box Turtle

- Taxonomy: Ernst and Barbour 1972; Ward 1978.
 Distribution: Taylor 1894; Ward 1978; Baxter and Stone 1980.
 Economic and legal status: Baxter and Stone 1980.
 Population characteristics: Legler 1960; Ernst and Barbour 1972; Metcalf and Metcalf 1979; Baxter and Stone 1980.
 Habitat utilization: Legler 1960; Webb 1970; Conant 1975; Baxter and Stone 1980; Hammerson and Langlois 1981.
 Feeding: Legler 1960; Metcalf and Metcalf 1970; Baxter and Stone 1980; Thomasson 1980.
 Breeding: Legler 1960.
 Space use and temporal activity: Rodeck 1950; Legler 1960; Stebbins 1966.
 Effects of habitat modification and management: Legler 1960; Ernst and Barbour 1972; Hudson 1972; Schwartz and Schwartz 1974; Stickel 1978; Holcomb and Parker 1979.
 Other: Timken 1968.

Trionyx spiniferus Western Spiny Softshell Turtle

- Taxonomy: Webb 1962, 1973; Collins et al. 1978.
 Distribution: Webb 1973; Baxter and Stone 1980.
 Economic and legal status: Lagler 1943.
 Population characteristics: Baxter and Stone 1980.
 Habitat utilization: Carr 1952; Webb 1962; Stebbins 1966; Black 1970b; Ernst and Barbour 1972; Baxter and Stone 1980; Hammerson and Langlois 1981; Williams and Christiansen 1981.
 Feeding: Webb 1962; Black 1970b; Ernst and Barbour 1972; Collins 1974; Froom 1976; Williams and Christiansen 1981.
 Breeding: Carr 1952; Webb 1956, 1962; Black 1970b; Ernst and Barbour 1972; Robinson and Murphy 1978.
 Space use and temporal activity: Webb 1962; Plummer and Shirer 1975; Williams and Christiansen 1981.
 Effects of habitat modification and management: Webb 1962; Fitch and Plummer 1975; Robinson and Wells 1975; Barclay 1980.
 Other: Timken 1968.

SauriaCnemidophorus sexlineatus Six-lined Racerunner

- Taxonomy: Collins et al. 1978; Baxter and Stone 1980.
 Distribution: Baxter and Stone 1980.
 Economic and legal status: Bury et al. 1978.
 Population characteristics: Werth 1972; Wyoming Game and Fish Dept. 1977; Baxter and Stone 1980; Jones and Droge 1980.
 Habitat utilization: Smith 1946; Stebbins 1954; Fitch 1958, 1967; Werth 1972; Baxter and Stone 1980; Hammerson and Langlois 1981.
 Feeding: Fitch 1958; Werth 1972; Ballinger et al. 1979.

Breeding: Fitch 1958; Carpenter 1960; Werth 1972; Clark 1976; Brackin 1979.
 Space use and temporal activity: Fitch 1958; Werth 1972.
 Effects of habitat modification and management: Fitch 1958; Hall 1980.

Eumeces multivirgatus Northern Many-lined Skink

Taxonomy: Mecham 1957; Collins et al. 1978; Mecham 1980.
 Distribution: Baxter 1947; Mecham 1957; Conant 1975; Baxter and Stone 1980; Mecham 1980.
 Economic and legal status: Bury et al. 1978.
 Population characteristics: Wyoming Game and Fish Dept. 1977; Baxter and Stone 1980.
 Habitat utilization: Smith 1946; Mecham 1957; Gehlbach and Collette 1959; Hudson 1972; Baxter and Stone 1980; Hammerson and Langlois 1981.
 Feeding: Hudson 1972; Baxter and Stone 1980.
 Breeding: Maslin 1957; Fitch 1970; Everett 1971; Baxter and Stone 1980.
 Space use and temporal activity: Baxter and Stone 1980.
 Effects of habitat modification and management: Hall 1980.

Holbrookia maculata Northern Earless Lizard

Taxonomy: Smith 1946; Collins et al. 1978.
 Distribution: Conant 1975; Bury et al. 1978; Baxter and Stone 1980.
 Economic and legal status: Collins 1974; Bury et al. 1978.
 Population characteristics: Wyoming Game and Fish Dept. 1977; Baxter and Stone 1980.
 Habitat utilization: Gennaro 1972; Werth 1972; Hoger 1976; Sena 1978; Baxter and Stone 1980; Jones and Droge 1980; Hammerson and Langlois 1981.
 Feeding: Smith 1946; Dixon and Medica 1967; Werth 1972; Collins 1974; Baxter and Stone 1980.
 Breeding: Fitch 1970; Werth 1972; Gennaro 1974; Hoger 1976; Droge et al. 1982.
 Space use and temporal activity: Gennaro 1972; Werth 1972; Jones and Droge 1980.
 Effects of habitat modification and management: Werth 1972; Hoger 1976; Baxter and Stone 1980; Hall 1980; Jones and Droge 1980; Jones 1981.

Phrynosoma douglassi Eastern Short-horned Lizard

Taxonomy: Smith 1946; Collins et al. 1978; Baxter and Stone 1980.
 Distribution: Baxter 1947; Stebbins 1954; Conant 1975; Bury 1978; Baxter and Stone 1980.
 Economic and legal status: Knowlton 1934; Bury et al. 1978.
 Population characteristics: Sharp 1979; Baxter and Stone 1980.
 Habitat utilization: Hayward 1948; Stebbins 1954, 1966; Hayward et al. 1958; Banta 1965; Reynolds 1979; Sharp 1979; Baxter and Stone 1980; Hammerson and Langlois 1981; Montanuucci 1981.

- Feeding: Knowlton 1934; Stebbins 1954; Pianka and Parker 1975; Baxter and Stone 1980.
 Breeding: Stebbins 1954; Fitch 1970; Goldberg 1971; Pianka and Parker 1975; Baxter and Stone 1980.
 Space use and temporal activity: Pianka and Parker 1975; Baxter and Stone 1980; Campbell and Clark 1981.
 Effects of habitat modification and management: Peterson 1974; Reynolds 1979; Hall 1980; Jones 1981.

Sceloporus graciosus Sagebrush Lizard

- Taxonomy: Kerfoot 1968; Collins et al. 1978.
 Distribution: Kerfoot 1968; Conant 1975; Bury et al. 1978; Baxter and Stone 1980.
 Economic and legal status: Bury et al. 1978.
 Population characteristics: Mueller 1969; Wyoming Game and Fish Dept. 1977; Baxter and Stone 1980.
 Habitat utilization: Kerfoot 1968; Mueller 1969; Ferguson 1971; Tinkle 1973; Turner 1974; Derickson 1976; Rose 1976; Reynolds 1979; Baxter and Stone 1980; Hammerson and Langlois 1981.
 Feeding: Woodbury 1932; Knowlton 1953; Stebbins 1954; Turner 1974; Rose 1976.
 Breeding: Mueller and Moore 1969; Ferguson 1971; Tinkle 1973; Turner 1974; Derickson 1976; Baxter and Stone 1980.
 Space use and temporal activity: Ferguson 1971; Tinkle 1973; Turner 1974; Campbell and Clark 1981.
 Effects of habitat modification and management: Punzo et al. 1979; Reynolds 1979; Hall 1980.

Sceloporus undulatus Eastern Fence Lizard

- Taxonomy: Smith 1946; Maslin 1956; Collins et al. 1978; Baxter and Stone 1980.
 Distribution: Baxter 1947; Conant 1975; Bury et al. 1978; Baxter and Stone 1980.
 Economic and legal status: Bury et al. 1978.
 Population characteristics: Wyoming Game and Fish Dept. 1977; Baxter and Stone 1980.
 Habitat utilization: Tanner 1965; Ferguson 1971; Tinkle 1972; Tinkle and Ballinger 1972; Werth 1972; Ferner 1974, 1976; Turner 1974; Baxter and Stone 1980; Jones and Droge 1980; Waldschmidt 1980; Hammerson and Langlois 1981.
 Feeding: Woodbury 1932; Johnson 1966; Werth 1972; Turner 1974; Ferner 1976; Baxter and Stone 1980.
 Breeding: Ferguson 1971; Tinkle 1972; Tinkle and Ballinger 1972; Turner 1974; Derickson 1976; Ferner 1976; Baxter and Stone 1980; Ferguson et al. 1980; Ballinger et al. 1981.
 Space use and temporal activity: Tanner 1965; Ferguson 1971; Werth 1972; Ferner 1974; Turner 1974; Jones and Droge 1980; Waldschmidt 1980; Ballinger et al. 1981.
 Effects of habitat modification and management: Ferguson 1963; Punzo et al. 1979; Hall 1980; Jones 1981.

Urosaurus ornatus Northern Tree Lizard

- Taxonomy: Ballinger and Tinkle 1972; Purdue and Carpenter 1972; Collins et al. 1978.
 Distribution: Stebbins 1966; Baxter and Stone 1980.
 Economic and legal status: Baxter and Stone 1980.
 Population characteristics: Wyoming Game and Fish Dept. 1977; Baxter and Stone 1980.
 Habitat utilization: Smith 1946; Stebbins 1954; Douglas 1966; Worthington and Sabath 1966; Baxter and Stone 1980; Hammerson and Langlois 1981.
 Feeding: Smith 1946; Stebbins 1954; Aspland 1964; Douglas 1966; Baxter and Stone 1980.
 Breeding: Douglas 1966; Fitch 1970; Martin 1973.
 Space use and temporal activity: Milstead 1970; Baxter and Stone 1980.
 Effects of habitat modification and management: Punzo et al. 1979; Hall 1980; Jones 1981.

Serpentes

Charina bottae Rubber Boa

- Taxonomy: Stebbins 1954; Cunningham 1966; Nussbaum and Hoyer 1974; Stewart 1977; Collins et al. 1978.
 Distribution: Baxter 1947; Stewart 1977; Baxter and Stone 1980.
 Economic and legal status: Baxter and Stone 1980.
 Population characteristics: Hoyer 1974; Wyoming Game and Fish Dept. 1977; Baxter and Stone 1980.
 Habitat utilization: Hayward 1948; Wright and Wright 1957; Hayward et al. 1958; Cunningham 1966; Hoyer 1974; Baxter and Stone 1980.
 Feeding: Wright and Wright 1957; Baxter and Stone 1980.
 Breeding: Tanner and Tanner 1939; Wright and Wright 1957; Fitch 1970.
 Space use and temporal activity: Wright and Wright 1957; Hoyer 1974; Baxter and Stone 1980.
 Effects of habitat modification and management: Baxter and Stone 1980; Hall 1980.

Coluber constrictor Racer

- Taxonomy: Auffenberg 1955; Collins et al. 1978; Wilson, 1978; Baxter and Stone 1980; Fitch et al. 1981.
 Distribution: Baxter 1947; Conant 1975; Bury et al. 1978; Wilson, 1978; Baxter and Stone 1980.
 Economic and legal status: Bury et al. 1978.
 Population characteristics: Peterson 1974; Wyoming Game and Fish Dept. 1977; Baxter and Stone 1980.
 Habitat utilization: Hayward 1948; Smith 1956; Hayward et al. 1958; Fitch 1963; Parker and Brown 1973; Peterson 1974; Brown and Parker 1976; Sharp 1979; Baxter and Stone 1980; Hammerson and Langlois 1981; Diller and Johnson 1982.

- Feeding: Fitch 1963; Ballinger et al. 1979.
 Breeding: Fitch 1963, 1970.
 Space use and temporal activity: Fitch 1963; Brown and Parker 1976; Baxter and Stone 1980; Sexton and Hunt 1980.
 Effects of habitat modification and management: Fitch 1963; Parker and Brown 1973; Brisbin et al. 1974; Peterson 1974; Fleet and Plapp 1978; Hall 1980.

Crotalus viridis Western Rattlesnake

- Taxonomy: Klauber 1972; Collins et al. 1978; Baxter and Stone 1980.
 Distribution: Baxter 1947; Smith 1963c; Conant 1975; Bury et al. 1978; Baxter and Stone 1980.
 Economic and legal status: Klauber 1972; Bury et al. 1978.
 Population characteristics: Baxter 1954; Wyoming Game and Fish Dept. 1977; Sharp 1979; Baxter and Stone 1980.
 Habitat utilization: Gloyd 1946; Anderson 1947; Hayward 1948; Woodbury 1951; Baxter 1954; Stebbins 1954, 1966; Wright and Wright 1957; Hayward 1958; Klauber 1972; Parker and Brown 1973; Peterson 1974; Diller 1981; Hammerson and Langlois 1981; Diller and Johnson 1982.
 Feeding: Hamilton 1950; Baxter 1954; Wright and Wright 1957; Klauber 1973; Baxter and Stone 1980; Diller 1981; Diller and Johnson 1982.
 Breeding: Wood 1933; Rahn 1942; Glissmeyer 1951; Baxter 1954; Fitch 1970; Klauber 1972; Baxter and Stone 1980; Diller 1981; Diller and Johnson 1982.
 Space use and temporal activity: Klauber 1972; U.S. Dept. of the Interior 1979; Baxter and Stone 1980; Jacob and Painter 1980; Campbell and Clark 1981; Diller 1981; Diller and Johnson 1982.
 Effects of habitat modification and management: Baxter 1954; Chace 1971; Klauber 1972; Parker and Brown 1974; Bauerle et al. 1975; Sharp 1979; Baxter and Stone 1980; Hall 1980.

Heterodon nasicus Plains Hognose Snake

- Taxonomy: Platt 1969; Collins et al. 1978.
 Distribution: Baxter 1947; Conant 1975; Bury et al. 1978; Baxter and Stone 1980.
 Economic and legal status: Bury et al. 1978.
 Population characteristics: Wyoming Game and Fish Dept. 1977; Sharp 1979; Baxter and Stone 1980.
 Habitat utilization: Stebbins 1954; Wright and Wright 1957; Platt 1969; Sharp 1979; Baxter and Stone 1980; Hammerson and Langlois 1981.
 Feeding: Edgren 1955; Platt 1969; Ballinger et al. 1979.
 Breeding: Platt 1969; Fitch 1970.
 Space use and temporal activity: Platt 1969.
 Effects of habitat modification and management: Platt 1969; Sharp 1979; Hall 1980.

Lampropeltis triangulum Milk Snake

- Taxonomy: Collins et al. 1978; Baxter and Stone 1980.
 Distribution: Baxter 1947; Conant 1975; Bury et al. 1978; Baxter and Stone 1980.
 Economic and legal status: Platt et al. 1973; Bury et al. 1978.
 Population characteristics: Wyoming Game and Fish Dept. 1977; Baxter and Stone 1980.
 Habitat utilization: Stebbins 1954; Wright and Wright 1957; Fitch and Fleet 1970; Peterson 1974; Baxter and Stone 1980; Hammerson and Langlois 1981.
 Feeding: Fitch and Fleet 1970; Baxter and Stone 1980.
 Breeding: Fitch 1970; Fitch and Fleet 1970.
 Space use and temporal activity: Fitch and Fleet 1970; Baxter and Stone 1980.
 Effects of habitat modification and management: Platt et al. 1974; Baxter and Stone 1980; Hall 1980.

Opheodrys vernalis Smooth Green Snake

- Taxonomy: Grobman 1941; Robins 1952; Smith 1963b; Peterson 1974; Conant 1975; Collins et al. 1978; Baxter and Stone 1980.
 Distribution: Baxter 1947; Smith 1963b; Peterson 1974; Conant 1975; Bury et al. 1978; Baxter and Stone 1980.
 Economic and legal status: Bury et al. 1978.
 Population characteristics: Peterson 1974; Wyoming Game and Fish Dept. 1977; Baxter and Stone 1980.
 Habitat utilization: Criddle 1937; Carpenter 1953a; Smith 1963b; Lang 1969; Collins 1974; Peterson 1974; Baxter and Stone 1980; Hammerson and Langlois 1981.
 Feeding: Chace 1971; Collins 1974; Gregory 1977.
 Breeding: Siebert and Hagan 1947; Fitch 1970; Peterson 1974.
 Space use and temporal activity: Collins 1974.
 Effects of habitat modification and management: Collins 1974; Peterson 1974; Platt et al. 1974; Conant 1975; Punzo et al. 1979; Hall 1980.

Pituophis melanoleucus Bull Snake

- Taxonomy: Collins et al. 1978; Ballinger et al. 1979; Baxter and Stone 1980.
 Distribution: Baxter 1947; Maslin 1964; Conant 1975; Bury et al. 1978; Baxter and Stone 1980.
 Economic and legal status: Bury et al. 1978; Baxter and Stone 1980.
 Population characteristics: Wyoming Game and Fish Dept. 1977; Baxter and Stone 1980.
 Habitat utilization: Hayward 1948; Stebbins 1954, 1966; Wright and Wright 1957; Hayward et al. 1958; Wheeler and Wheeler 1966; Parker and Brown 1973; Peterson 1974; Sharp 1979; U.S. Department of the Interior 1979; Baxter and Stone 1980; Hammerson and Langlois 1981; Diller and Johnson 1982.

- Feeding: Stebbins 1954; Wright and Wright 1957; Ballinger et al. 1979; Baxter and Stone 1980; Diller 1981; Diller and Johnson 1982.
- Breeding: Wright and Wright 1957; Wheeler and Wheeler 1966; Fitch 1970; Diller 1981; Diller and Johnson 1982.
- Space use and temporal activity: U.S. Dept. of the Interior 1979; Baxter and Stone 1980; Campbell and Clark 1981; Diller 1981; Diller and Johnson 1982.
- Effects of habitat modification and management: Wright and Wright 1957; Korschgen 1970; Brisbin et al. 1974; Bauerle et al. 1975; Baxter and Stone 1980; Hall 1980.

Storeria occipitomaculata Black Hills Redbelly Snake

- Taxonomy: Trapido 1944; Smith 1963a; Peterson 1974; Collins et al. 1978.
- Distribution: Peterson 1974; Conant 1975; Baxter and Stone 1980.
- Economic and Legal Status: Bury et al. 1978.
- Population characteristics: Peterson 1974; Wyoming Game and Fish Dept. 1977.
- Habitat utilization: Criddle 1937; Trapido 1944; Carpenter 1953; Smith 1963a; Lang 1969; Chace 1971; Peterson 1974; Baxter and Stone 1980.
- Feeding: Wright and Wright 1957; Baxter and Stone 1980.
- Breeding: Blanchard 1937; Trapido 1940; Wright and Wright 1957; Peterson 1974.
- Space use and temporal activity: Wright and Wright 1957; Lang 1969.
- Effects of habitat modification and management: Platt et al. 1974; Hall 1980.

Thamnophis elegans Wandering Garter Snake

- Taxonomy: Fox 1951; Collins et al. 1978.
- Distribution: Baxter 1947; Smith 1963c; Stebbins 1966; Bury et al. 1978; Baxter and Stone 1980.
- Economic and legal status: Bury et al. 1978.
- Population characteristics: Wyoming Game and Fish Dept. 1977; Scott 1978; Baxter and Stone 1980.
- Habitat utilization: Hayward 1948; Carpenter 1953; Stebbins 1954; Wright and Wright 1957; Hayward et al. 1958; Fleharty 1967; Peterson 1974; Scott 1978; Baxter and Stone 1980; Hammerson and Langlois 1981; Scott et al. 1982.
- Feeding: Tanner 1949; Wright and Wright 1957; Fleharty 1967; Baxter and Stone 1980; Gregory et al. 1980.
- Breeding: Wright and Wright 1957; Fitch 1970; Baxter and Stone 1980.
- Space use and temporal activity: Scott 1978; Scott et al. 1982.
- Effects of habitat modification and management: Tanner 1949; Peterson 1974; Barclay 1980; Hall 1980.

Thamnophis radix Western Plains Garter Snake

- Taxonomy: Collins et al. 1978; Baxter and Stone 1980.
 Distribution: Baxter 1947; conant 1975; Bury et al. 1978; Baxter and Stone 1980.
 Economic and legal status: Bury et al. 1978.
 Population characteristics: Wyoming Game and Fish Dept. 1977; Sharp 1979; Baxter and Stone 1980.
 Habitat utilization: Criddle 1937; Stebbins 1954; Wright and Wright 1957; Wheeler and Wheeler 1966; Collins 1974; Gregory 1977; Baxter and Stone 1980; Hammerson and Langlois 1981.
 Feeding: Wright and Wright 1957; Gregory 1977; Ballinger et al. 1979; Baxter and Stone 1980.
 Breeding: Wright and Wright 1957; Fitch 1970; Gregory 1977; Baxter and Stone 1980.
 Space use and temporal activity: Collins 1974; Baxter and Stone 1980.
 Effects of habitat modification and management: Punzo et al. 1979; Barclay 1980; Hall 1980.

Thamnophis sirtalis Common Garter Snake

- Taxonomy: Fitch and Maslin 1961; Collins et al. 1978; Baxter and Stone 1980.
 Distribution: Baxter 1947; Stebbins 1966; Bury et al. 1978; Baxter and Stone 1980.
 Economic and legal status: Bury et al. 1978.
 Population characteristics: Aleksuk 1976; Wyoming Game and Fish Dept. 1977; Baxter and Stone 1980.
 Habitat utilization: Stebbins 1954; Wright and Wright 1957; Fitch 1965; Aleksuk and Stewart 1971; Collins 1974; Baxter and Stone 1980; Hammerson and Langlois 1981.
 Feeding: Wright and Wright 1957; Fitch 1965.
 Breeding: Fitch 1965, 1970; Aleksuk and Gregory 1974.
 Space use and temporal activity: Fitch 1965; Campbell and Clark 1981.
 Effects of habitat modification and management: Korschgen 1970; Brisbin et al. 1974; Dimond et al. 1975; Punzo et al. 1979; Barclay 1980; Hall 1980; Heinz et al. 1980.

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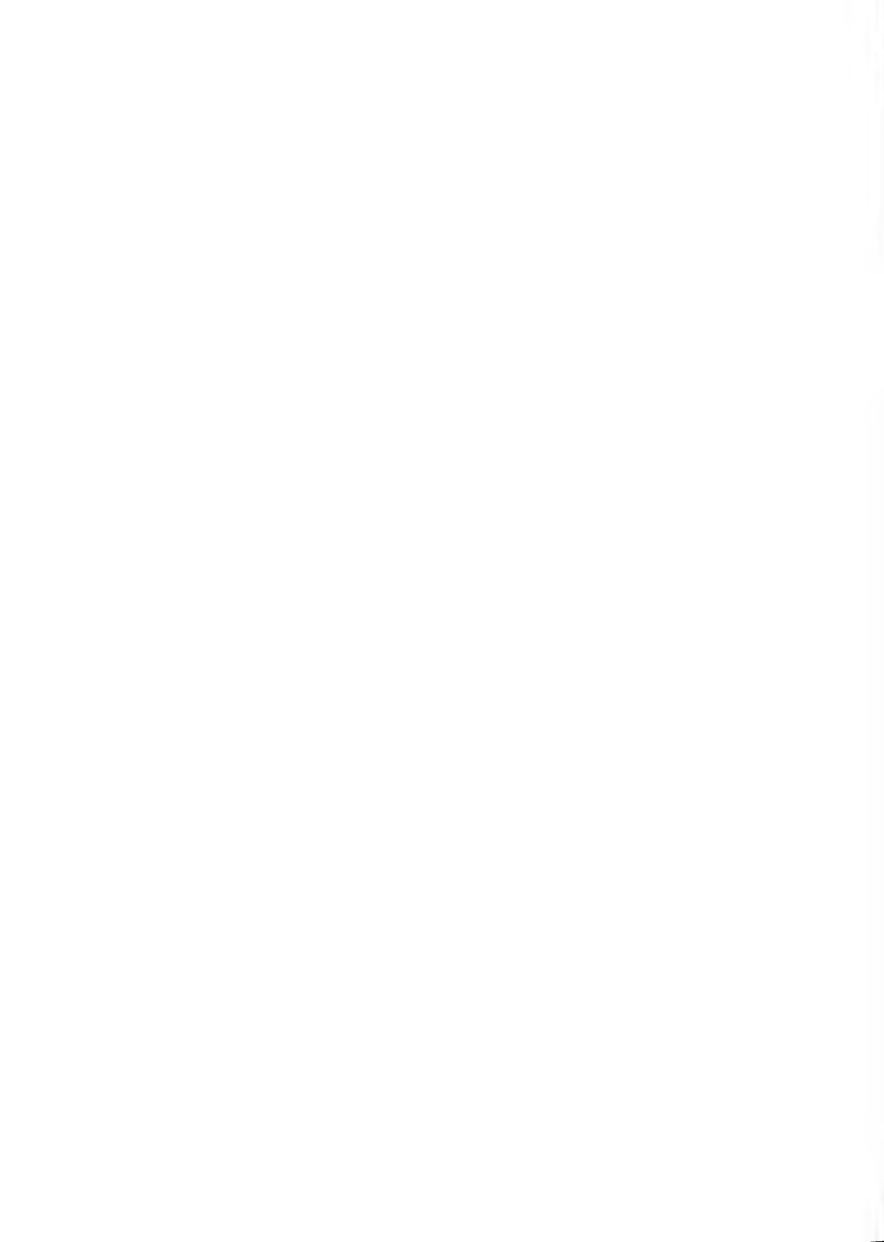
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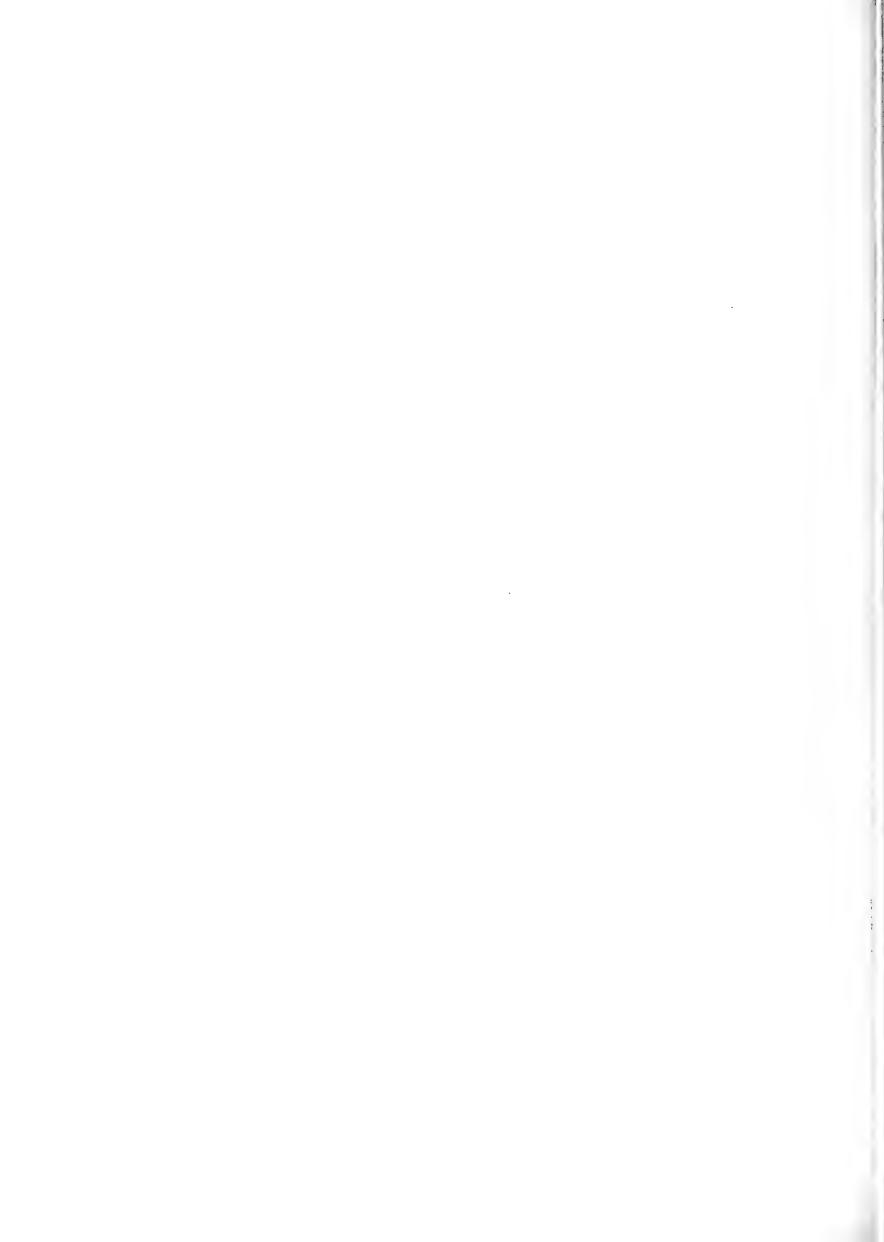
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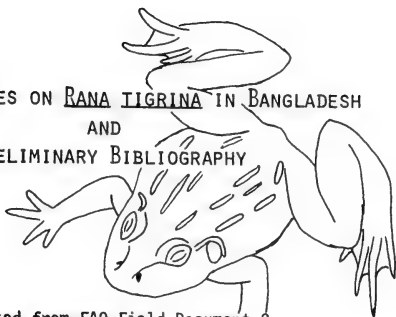






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BIOLOGICAL NOTES ON RANA TIGRINA IN BANGLADESH
AND
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Extracted from FAO Field Document 2

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"An evaluation of the populations of
the commercially exploited frog
Rana tigrina in Bangladesh"

CHARLES M. FUGLER

Department of Biological Sciences
University of North Carolina at Wilmington

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INTRODUCTION

An intensive search of the literature pertaining to Rana tigrina and to other commercially exploited anurans of southeast Asia reveals a paucity of published data on the biology of the species in question. Those published studies pertaining to the biology of Rana tigrina concern populations of northern and western India in which the environmental conditions are significantly divergent from those of Bangladesh. The systematics and biogeography of Rana tigrina are well documented.

The data herein are the only significant biological information extant on Rana tigrina from the Indian subcontinent. In view of the temporal restrictions within which the field studies were pursued, the conclusions drawn are tentative.

Rana tigrina is widely distributed through the subcontinent of India and southeast Asia. Its populations are most abundant in wetlands, natural and artificial, and are absent from, or uncommon in, forested areas.

Rana tigrina is known to inhabit all districts of Bangladesh, avoiding, as far as known, the immediate coastal areas. The greatest population densities are in the Districts of Mymensingh and Sylhet. The species is less frequently encountered, exclusive of the coastal areas, in the Chittagong Hill Tracts.

The current study is concerned with the status of the Bangladeshi populations as it pertains to size-cohorts, reproductive data and food preferences.

AMPHIBIAN FAUNA OF BANGLADESH

Husain and Rahman (1978) reported eleven species from Bangladesh (Bufo melanostichus, Kaloula pulchra, Microhyla ornata, M. rubra, Rana cyanophlyctis, R. hexadactyla, R. limnocharis, R. tigrina, R. tytleri, Rhacophorus leucomastix, Rh. maculatus). Although incompletely documented, the amphibian fauna of Bangladesh, when compared to those of adjacent regions, is impoverished. Intensive field collecting may increase the number of species within the national boundaries. The absence of significant physiographic and phytogeographic diversity will negate a significant faunistic increase.

One species (R. tigrina) and possibly two other species (R. hexadactyla, R. limnocharis) are of significant economic value. Husain and Rahman (1978) noted, for the six-month period July 1975 to January 1976, the foreign exchange earned by the export of frozen frog-legs was Taka 6,474,434 (approximately U. S. \$359,000) according to the official statistics of the Bangladesh Export Promotion Board.

REPRODUCTION

In Bangladesh, the breeding season is initiated at the onset of the first seasonal rains, usually mid-April. Reproductive activity is intense through mid-July (K. Z. Husain, personal communication). A seasonal rainfall will activate feeding and reproductive behavior. An early (February 1982) rainfall at Mymensingh was sufficient to initiate breeding responses. The larvae survived and subsequently metamorphosed because of abundant standing water. At Barisal, aseasonal rain induced breeding activity, but the larvae failed to survive in the absence of standing water. Rana tigrina, therefore, is an opportunistic breeder in which rainfall elicits reproductive behavioral responses. Reproductive activity continues well into the monsoonal season, diminishing in intensity and frequency correlative to the decrease in intensity and frequency of rainfall.

Rana tigrina oviposits in "new water" of the monsoon rather than in stagnant waters depleted of oxygen. In "new water" less particulate matter is present, the temperature is lower and the oxygen content is higher. The abiotic requirements for larval development are, in part, fulfilled.

At the advent of the breeding cycle the males, the first to emerge from underground retreats, begin frenetic pre-reproductive activities, establishing territories by emitting species-specific calls. The voiceless female is thereby attracted to the territorial male. The chorusing males are highly vulnerable to predators.

Daniel (1975) observed similar reproductive behavior in Rana tigrina near Bombay, India. The males, lemon-yellow in color, congregate in rainwater pools and ditches, chorusing loudly as they await the females. The arriving females are fought over, the nearest male clasping the female, fending off competitors by kicking strongly with the hind legs. The spawn is deposited in rainwater pools and in other transitory waters. The ova float upon deposition, thence sink to the bottom where they remain until hatching.

Dutta and Mohanty-Hejmadi (1978) concluded that Rana tigrina has the most rapid developmental rate among local (Vani Vihar, Bhubaneswar, India) amphibians. At the aforementioned localities hatching occurs 23 hours postfertilization, external gills at 44 3/4 hours, limb buds at 19 days, well defined limbs and tail at 30 days, and complete metamorphosis at 33 days. Rana tigrina attains metamorphosis at 43 days postfertilization under controlled laboratory conditions. Breeding during the monsoon and rapid larval development permit escape from the pressures of dessication and diminished larval predation attendant upon other sympatric amphibian species (Dutta and Mohanty-Hejmadi, 1978).

SIZE VARIATION

Few published references pertaining to the maximum snout-vent length of Rana tigrina are extant. Issac and Rege (1975) recorded on unsexed individual (unquestionably female) measuring 175 mm snout-vent length from Bombay. In western India, adult females occasionally exceed 160 mm snout-vent length. Males are invariably of lesser snout-vent length, although Mansukhani and Murthy (1970) claimed that males range from 178 mm to 188 mm, and females from 132 mm to 152 mm, snout-vent length, in Rajasthan, India. These data, obviously a size reversal of sexual morphometrics, are not corroborated by published observations. Murthy (1968) noted that females attain a larger size (178 mm - 188 mm) than males (143 mm - 165 mm) when sexually mature (Madras, India).

Eight population samples, randomly selected, of Rana tigrina from diverse districts of Bangladesh suggest that the mean snout-vent length of both sexes is significantly less than those of the Indian conspecifics although comparative data are minimal.

Males.--The mean size-cohort of males is 101-110 mm (24% of all males examined) although 23.1% of all males examined are in the 91-100 mm size-cohort. Thus, approximately 50% of the males examined measure from 91 mm to 110 mm in snout-vent length. Males greater than 150 mm snout-vent length were not encountered in the population sample (Table 1).

Males are the first emergents at the onset of the monsoonal rains. Those males of larger size are immediately removed from the reproductively active populations by the field collectors. The vociferous calls and breeding colors attract the attention of predators, human and others. The breeding stock, therefore, is composed of smaller males.

In the population samples obtained in early May and early June, the mean size-cohorts of males are 121-130 mm and 131-140 mm. The mean size-cohorts of later populations decline to 91-100 mm and 101-110 mm.

Females.--The mean size-cohort of females, 111-120 mm, includes 24.1% of all females examined. The size-cohort 121-130 mm contains 11.3% of all females examined. Less than 1% of the 915 females examined exceed 150 mm snout-vent length.

The mean size-cohorts of females in population samples of early May and early June are 111-120 mm and 131-140 mm. Later population samples, with slight fluctuation, decline to mean size-cohorts of 111-120 mm and ultimately to 91-100 mm.

Females emerge from hibernation after males and thence enter reproductive activities. The mean size-cohorts of the females, with slight fluctuation, exhibit a decline from early June (131-140 mm). The fluctuation in mean size-cohort may be attributable to local climatic conditions, primarily the onset of the monsoonal rains.

The distribution of snout-vent frequencies suggest that the populations of Bangladesh are severely stressed if the maximal snout-vent lengths of the Indian populations are characteristic of the species. That the Bangladeshi populations represent a geographic variant not conspecific with those of India is implausible should snout-vent length be considered a primary criterion.

Postmetamorphic growth.--The growth rates of Rana tigrina under natural and under laboratory conditions are unknown. The mean size-cohort frequencies of the populations obtained in May and June do not evidence bimodality characteristic of annual size-classes. It may be suggested that the mean size-classes represent those individuals surviving one growth-season and the following period of inactivity. Those individuals, with significant overlap, exceeding the mean size-cohort, may have survived two growth-seasons. Individuals of lesser snout-vent length are possibly recruits of the previous growth-season.

Base line data on this extremely important aspect of the biology of Rana tigrina are urgently required. It is certainly possible that growth rates vary within the districts of Bangladesh according to the length and abundance of rainfall, availability of food, intensity of predation and extremes of temperature.

SIZE AND TEMPORAL DISTRIBUTION OF GRAVID FEMALES

The ovaries of all females in the population samples were closely examined to ascertain the reproductive state, i.e., early oogenesis (minute, immature ova, few in number), later oogenesis (larger, immature ova, relatively abundant), mature (fully formed ova, pigmented, abdominal cavity extended) and depleted (postspawning, few or no ova remaining, oviducts greatly enlarged).

Gravid females comprise a significant preponderance of all females in the population samples examined between 16 May 1982 and 29 June 1982: 93.57%, 100% (5, 6, 9 June), 91.66%, 84.11%, 97.87% and 85.71% (Table 1).

Gravid females are present in the 71-80 mm size-cohort, the 161-170 mm size-cohort and all intervening size-cohorts. It is established, therefore, that individuals between 71-80 mm and 161-170 mm snout-vent length are reproductively mature.

The frequencies of gravid females larger than and smaller than the mean size-cohort of each population examined decline correlatively with the decrease of snout-vent frequencies. Except for the population obtained 5 June 1982 (141-150 mm), the mean size-cohorts of gravid females among the population samples vary from 111-120 mm, 121-130 mm and 91-100 mm.

The reproductive potential of larger females, producing larger egg masses and thereby more abundant larvae, is negated by their prompt removal from the reproductive pools. Females of smaller size produce fewer ova, thus reducing the recruitment potential, given the high level of larval mortality.

In certain, if not all, areas of Bangladesh in which Rana tigrina exists, females are reproductively mature by mid-May and remain so until at least early July. The data do not indicate if Rana tigrina oviposits single or multiple clutches throughout its geographic range or if the frequency of spawning varies regionally. In females from the Districts of Mymensingh and Sylhet the field data suggest that multiple spawning may occur during lengthy and unabated monsoonal seasons. In other districts in which the monsoon is of shorter duration, multiple spawning is not indicated by the data.

The sex-ratios of the populations examined varied thusly (males-females): 51.17 - 48.83%, 45.07 - 56.93%, 84.0 - 16.0%, 59.3 - 40.0%, 67.0 - 33.0%, 40.0 - 60.0%, 52.1 - 47.9%, and 63.0 - 37.0%.

Males are predominant in the larger population samples and females in the smaller. Males emerge before the females after the advent of the monsoons, and establish temporary breeding territories. The ceaseless nocturnal chorusing and intensified breeding colors attract predators and collectors. Thus, the sex-ratio strongly favors males in all population samples obtained from mid-May to late June. The females, emerging later from estivation than males, are voiceless and less spectacularly colored. They are more easily overlooked by predators and collectors. The sex-ratios of the population samples are strongly biased in that collectors seek or are attracted to the males.

The percentage of gravid females of all females examined varied from 38.93% to 98.0% in large population samples (Table 1). The lesser percentage is derived from females perhaps obtained prior to the beginning of the permissible collecting period and retained in holding tanks. The higher percentages indicate that a significant number of reproductively mature females are removed from the breeding populations.

FOOD PREFERENCES

In Bangladesh, a preliminary analysis of the stomach contents of Rana tigrina was undertaken on specimens collected in the Districts of Mymensingh, Chittagong, Noakhali, Sylhet, Khulna, Jessore, Rangpur and Bogra.

One-hundred-ten individuals were examined, ranging in snout-vent length from 33 mm to 140 mm. The mean (42.7%) ranged from 61 mm to 90 mm, followed by 31 mm to 60 mm (31.8%), 91 mm to 120 mm (17.2%), 121 mm to 150 mm (7.2%) and 151 mm to 180 mm (0.9%).

The one-hundred-ten specimens were obtained between 16 September and 13 November 1976 (data obtained from the Faculty of Fisheries, Bangladesh Agriculture University). Air temperature varied from 21.5°C to 30.5°C during the collecting period. Water temperature varied from 19°C to 30°C. All specimens were captured either in aquatic habitats or those characteristically moist throughout the year.

As reported in the study of Rana tigrina near Bombay, India (Issac and Rege, 1975), Coleoptera constitute the greatest volume of prey, followed in decreasing volumes by Orthoptera, Anura, Hymenoptera and Arthropoda (decapod crustacean). Coleopterans were the most frequently encountered organisms in 94 stomachs (16 contained no organisms) followed in decreasing frequencies by Hymenoptera, Orthoptera, Diptera, Lepidoptera and Hemiptera. The dietary elements indicate the abundance of prey species from mid-September until mid-November. The prey species consumed by Rana tigrina at other periods are not documented. In that Rana tigrina is a carnivorous, indiscriminate predator, the diet unquestionably reflects the relative abundance of invertebrates.

In Bangladesh, as well as in India, Rana tigrina is a significant agent of biological control. In those areas in which the populations are stressed, observations indicate that noxious insects and agricultural pests have rapidly increased. The ultimate control of the insects, therefore, may depend upon the use, or the increased use, of insecticides.

TABLE 1

Meristic and Reproductive Characteristics of Rana tigrina
 Obtained in the Districts of Faridpur, Khulna, Kustia, Comilla,
 Mymensingh, Barisal, Sylhet and Chittagong, 16 May-29 June, 1982

<u>Snout-Vent Length in mm</u>	<u>% of Total Males in Size-Cohort</u>	<u>% of Total Gravid Females in Size-Cohort</u>
161 - 170	-	0.1
151 - 160	-	0.6
141 - 150	1.3	3.8
131 - 140	7.0	12.7
121 - 130	14.7	21.3
111 - 120	17.5	24.1
101 - 110	24.1	19.0
91 - 100	23.1	13.1
81 - 90	10.6	4.6
71 - 80	1.2	0.3
61 - 70	0.1	-
Total Males Examined - 960		Total Gravid Females
		Examined - 821
		Total Females
		Examined - 915

TABLE 2

Analysis of Stomach Contents of Rana tigrina From
Eight Localities in Bangladesh

<u>Taxonomic Group</u>	<u>Total Number of Items Found in Stomachs</u>	<u>Number of Stomachs</u>	<u>% Volume of Food Items in all Stomachs</u>
Ephemeroptera	1	1	0.020
Odonata	1	1	0.161
Orthoptera	(33)	-	21.158
Tridactylidae	1	1	0.121
Gryllotalpidae	2	1	0.800
Acrididae	2	2	0.242
Gryllidae	28	20	19.995
Dermaptera			
Forficulidae	2	2	0.323
Hemiptera			
S. O. Heteroptera	(8)	-	0.040
Reduviidae	4	1	0.242
Coreidae	1	1	0.040
Pantatomidae	2	2	0.484
S. O. Homoptera	2	1	0.080
Cicadellidae	1	1	0.121
Neuroptera	1	1	0.201
Lepidoptera	(9)	-	2.381

Pyrilidae	1	1	0.121
Geometridae	1	1	0.201
"Hairy Caterpillar"	4	3	1.050
Diptera	(21)	-	2.099
Tipulidae	2	2	2.201
Muscidae	14	10	1.456
S. O. Cyclorrapha	5	1	8.242
Homoptera	(212)	-	8.922
Formicidae	209	35	7.549
Vespidae	3	2	1.131
Coleoptera	(160)	-	34.935
Carabidae	109	55	29.921
Curculionidae	17	7	1.959
Scarabaeidae	22	9	1.745
Staphylinidae	3	3	0.262
Coccinellidae	1	1	0.161
Chrysomellidae	6	8	0.686
Grub	1	1	0.121
Aquatic Beetle (Coleoptera)	1	1	0.080
Annelida	15	3	3.958
Crab (Crustacea Decapoda)			
Complete	1	4	7.109
Fragments	23		

Millipede (Diplopoda)	9	5	1.050
Spider (Arachnida)	6	6	0.686
Snail (Gastropoda)	19	9	2.302
Cypriniformes (Pisces)	2	2	4.039
Anura	3	3	11.391
Plant Material	-	8	-
Rice	2	2	-
Rocks	2	2	-
Mud	-	7	-

A PRELIMINARY BIBLIOGRAPHY OF RANA TIGRINA DAUDIN

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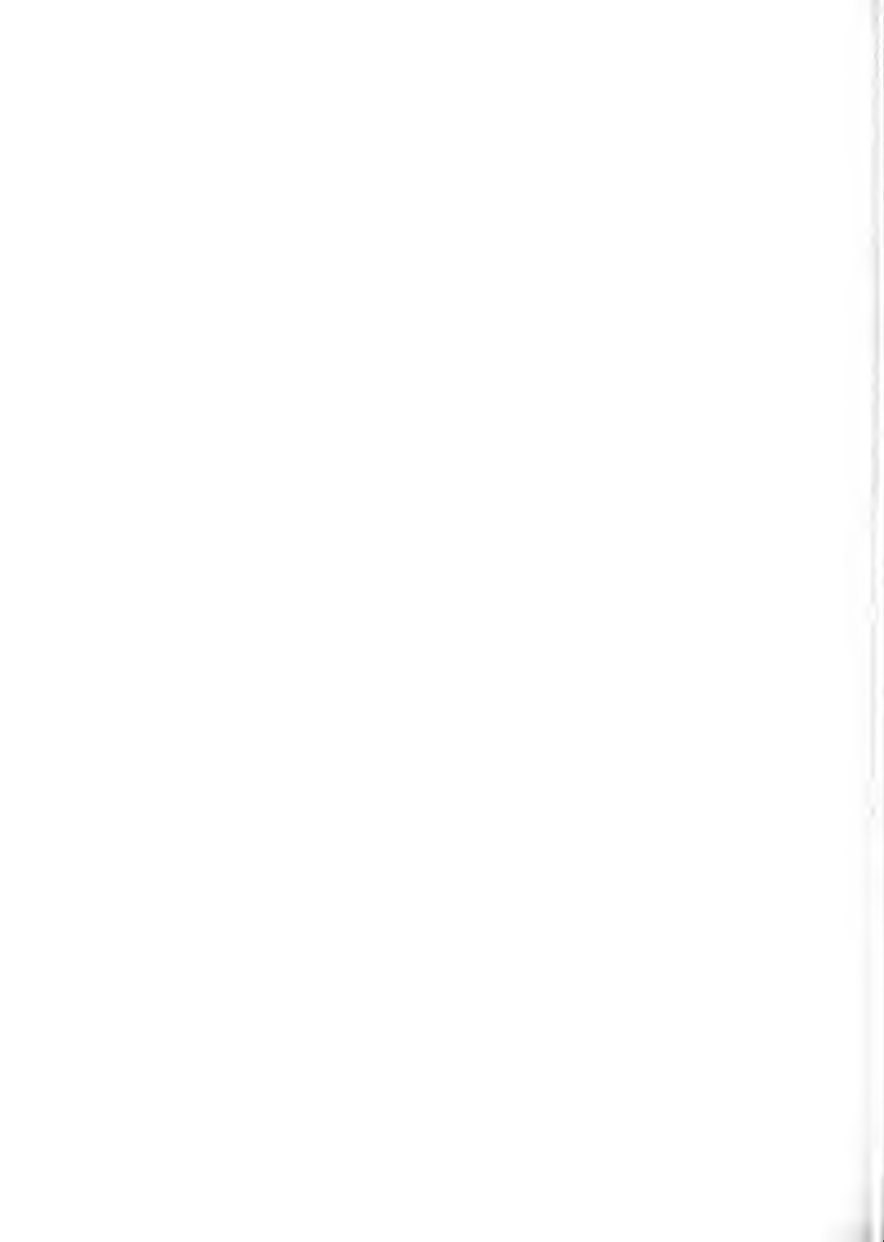
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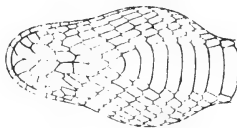
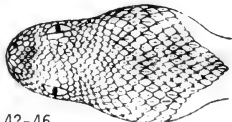
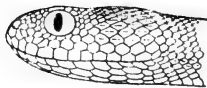






NEW FACTS ON THE TAXONOMY OF SNAKES
OF THE
GENUS ECHIS

Vladimir A. Cherlin
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Carpet vipers occupy a wide area from the northwestern coast of Africa to the delta of the Ganges and from the Aral Sea to the equator in Kenya. A large number of taxa has been described, but due to the absence of a general treatment it has until now been impossible to correctly evaluate their status (Hughes 1976, Boehme 1978)

In addition to its theoretical interest, the problems of carpet viper taxonomy are also of considerable practical interest. Carpet vipers possess virulent venoms dangerous to human beings (Deoras & Vad 1965-1966, Hughes 1976, and others). From the experience of medical establishments, anti-venom sera appear effective only when treating snake bites of those taxonomic groups from whose venoms a serum has been prepared, otherwise the consequences of the bites are likely fatal. For instance, sera prepared in Africa have no therapeutic effect when applied in Iran and, in Nigeria, mortality of people during treatment with sera manufactured in Teheran or Paris is nearly 20%.

All this compelled me to undertake a comprehensive study of snakes of the genus Echis in order to develop a more natural classification.

In 1801, Schneider described the snake Pseudoboa carinata from Arni near Madras, India (Schneider 1807), now known as Echis carinatus. In 1827, Geoffrey Saint Hilaire distinguished Scytale pyramidum, now called E. c. pyramidum, from the territory of Egypt (Geoffrey Saint Hilaire 1827). In 1878, Gunther described E. arenicola (now E. coloratus) from Arabia (Gunther 1878). In 1949, Constable referred snakes from northern India to E. c. pyramidum (Constable 1949). In 1951, Deraniyagala described E. c. sinhalensis from Ceylon (Deraniyagala 1951). S. A. Chernov noted that vipers from central Asia and Iran are different from the vipers of Egypt but he did not have adequate samples of these snakes from Africa in order to reach definitive conclusions (Chernov 1930). From 1969 onwards, a number of articles devoted to the taxonomy of vipers appeared, Stemmler and Sochurek distinguished E. c. leakeyi from Lake Daringo in Africa *(Stemmler and Sochurek 1969), while Stemmler described E. c. sochureki from northern India, Pakistan, Iran, Afghanistan and central Asia (Stemmler 1969). In 1970, Mertens described E. c. astoles from the Astole Island in Pakistan (Mertens 1970). In the same year, Stemmler also described E. c. ocellatus from the "northern coast of the Gulf of Guinea" *(Stemmler 1970). Then in 1972, Roman

* Cherlin says wrongly Lake Rudolph (now Lake Turkana) - B.H.

** The type is actually from Garange, Upper Volta - B.H.

identified E. c. leucogaster from south of the Sahara (Roman 1972) and, in 1975, he elevated this form to the taxonomic status of E. leucogaster (Roman 1975). Drews and Sacharer described E. c. allaborri from northeastern Kenya (Drews and Sacharer 1974). In 1976, Hughes identified E. ocellatus as a separate species (Hughes 1976). In 1981 the author of this work described E. multisquamatus from central Asia and the adjacent regions of Asia (Cherlin 1981).

MATERIAL

The following abbreviations are used [letters A to Q substituted; I and O omitted. B.H.]:

- A Zoological Institute, USSR, Leningrad.
- B Zoological Museum, Moscow State University, Moscow.
- C American Museum of Natural History, New York.
- D British Museum (Nat. Hist.), London.
- E Zoologisches Forschungsinstitut und Museum
Alexander Koenig, Bonn.
- F Naturhistorisches Museum, Vienna.
- G Field Museum of Natural History, Chicago.
- H Museum of Comparative Zoology, Harvard University,
Cambridge.
- J Museum National d'Histoire Naturelle, Paris.
- K Zoologisches Museum, Humboldt Universitaet Berlin.
- L Rijksmuseum van Natuurlijke Historie, Leiden
- M National Museum of Natural History, Smithsonian
Institution, Washington.
- N Museum d'Histoire Naturelle, Geneva.
- P Museo Civico di Storia Naturale Genova.
- Q Naturhistorisches Museum, Basel.

Disposition of specimens [and number of specimens] from countries as follows:

USSR	A56, B25	81
Afghanistan	C1, E1, G2	4
Pakistan	G47, D2, E1, G3, H3, E7, L1, Q1	75
India	A1, C3, D4, E13, G2, H5, J1, K3, L3, M1	36
Sri Lanka	A1, N5, Q3	9
Iran	A11, E6, G11, M4, N2	34
Arabia	G11, H3, K4, Q24, C6, K2, J1	51
Libya	A5, G14, J4, L4, M18	45
Algeria	D1, N1, P1, Q1	4
Morocco	D2, E2, J1, L2	7
Mauretania	M1	1
Mali	J1	1
Senegal	M22	22
Cameroons	K3	3
Upper Volta	K1	1
Benin	M6	6
Togo	M2	2
Nigeria	D1	1
Sudan	C1, D9, G1	11
Ethiopia	A4, D13, E4, J3, P2, Q2	28
Kenya	C1, H22, J1, K1	25
Somalia	A1, D15, G1, H1, K2, P1	21
Djibouti	J1	1
Total:		466

We also acquainted ourselves with the E. c. carinatus x E. c. sochureki hybrid (Berlin #18565).

RESULT

We studied the variability of the scale arrangements of the head, body, and tail (a total of 15 characters), a number of meristic parameters and indices as well as color patterns of the head and body of vipers throughout the entire range of the genus. This enabled us to identify characters which show almost the same variation in nearly all the groups as well as other characters whose variations appear specific to a complex of taxonomic groups. The latter characters are discussed below. However, before each of them is examined separately, it is important to note that distribution of the genus Echis encompasses three zoogeographical regions, Palaearctic, Indo-Malaysian and Ethiopian. Since the distribution of the characters recorded by us appeared related to zoogeographic provenance, we shall henceforth call the vipers found in each of these regions Paleasiatic, Indian and African. Also, it must be noted that none of the currently described taxonomic groupings of vipers occurs in more than one zoogeographical area.

Scale Arrangement on the Throat* (size and shape of the scales).

Four variants of scale arrangement are recognized by us: the [median] scales of the throat differ neither in size nor shape from other scales on the throat (Fig. 1a); the median scales of the throat are sharply enlarged in size on each side of the midline forming longitudinal rows, [thus] differ from the other scales (Fig. 1b); the scales of the throat are enlarged, but they are not all the same size (Fig. 1c); intermediate variant between "a" and "b" when the posterior scales of the throat are arranged in two equal rows but very weakly enlarged (Fig. 1d).

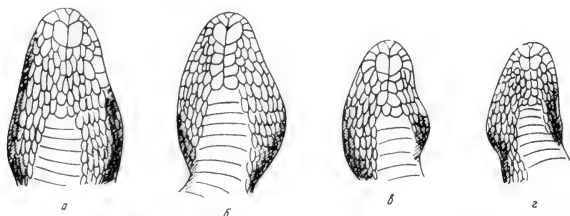


Fig. 1. Various arrangements of the throat scales of carpet vipers (explanation in the text).

Paleoasiatic vipers possess the type "a" scale arrangement on the throat. Of the 235 snakes of this group examined, only three had the type "d" scale arrangements. The throat scales of the African vipers correspond to type "b", rarely "c" and more rarely "d".

Number of the Dorsal Scales Rows at Midbody.

According to the values of this character, vipers are divisible into two large groups: (a) vipers with 30 to 40 midbody scale rows (and not more than 1.5% of the snakes in this group have 28-29 midbody scale rows), the average number of small scales in the taxonomic groups is not less than 31; and (b) vipers with from 24 to 32 body scale rows - the average number in this group is not more than 31.

All the Paleoasiatic vipers belong to group "a" whereas all Indian and African snakes belong to group "b".

* lower jaw" was used in the original - B.H.

Markings on the Top of the Head.

Even though the variability of the pattern on the top of the head is very great, depending on the [pattern's] shape and the amount of simplification, it is possible to recognise two large groups: 1) a pattern with one transverse element

(like the tip of a spear - Fig. 2a) and its modifications which relate to the reduction of the sides of the pattern and convert the pattern into either a broad cross (Fig. 2b) or a narrow cross (Fig. 2c); 2) a pattern with two transverse elements forms as a result of the reduction of the sides and the middle part of the tip of the spear; sometimes it divides vertically into two (Fig. 2d) sometimes it becomes indiscernible.

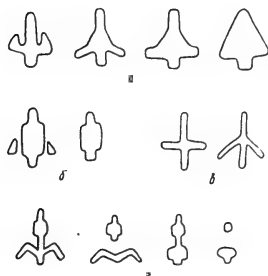


Fig. 2. The pattern on the top of the head. Modifications of the pattern with one transverse element. a - tip of a spear, b - broad cross, c - narrow cross; d - modifications of the pattern with two transverse elements.

Paleoasiatic vipers have the pattern of the first group with modifications mainly towards a narrow cross. Indian vipers also have the pattern of the first group but with modifications mainly towards a broad cross; all African vipers have the pattern of the second group.

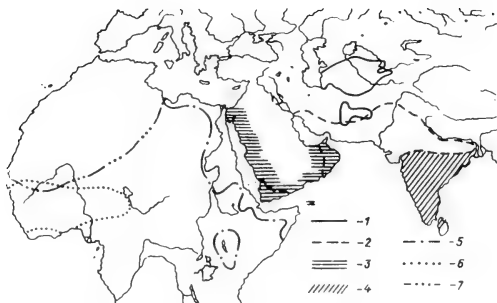


Fig. 3. Geographical distribution of species of snakes of the genus Echis: 1 - E. multisquamatus, 2 - E. sochureki, 3. - E. coloratus, 4 - E. carinatus, 5 - E. pyramidum, 6 - E. ocellatus, 7 - E. leucogaster.

It must be strongly emphasized that the characters recognized above are less variable in comparison to others - for instance, the ventral scale count, pattern on the body, etc.- and that the character complex of each taxonomic group in each zoogeographic region is stable. For example, the Palearctic vipers have the same number of midbody scale rows (more than 31), the same throat scale pattern, and the head pattern is of the tip of a spear or its modifications in the direction of a narrow cross. Sometimes the pattern on the head may be completely reduced (E. coloratus).

The Indian and African vipers possess to a different degree enlarged scales on the back of throat and the number of the small midbody scale rows is less than 31; these groups differ in the pattern on the head - the Indian vipers have the pattern of the tip of the spear or its modification in the direction of a broad cross, whereas the African vipers have the pattern with two transverse elements or it may be reduced completely.

The facts stated above make it possible to suggest that the vipers found in different zoogeographical regions differ much more from one another than the vipers within each zoogeographic region differ amongst themselves. This statement in turn has an important implication: since it has been shown beyond doubt that there are independent species among vipers within the same zoogeographic regions, vipers in different regions cannot belong to one species. In this case, the presence of hybrids between vipers from different

zoogeographic groupings (e.g., sochureki x carinatus - Zoologisches Museum der Humboldt Universität, Berlin no. 18565; coloratus x leakeyi, Lehmann 1980) obtained in captivity, cannot contradict this statement since, in the first place, in view of the great polymorphism of vipers, hybrid analysis is relevant only with regard to vipers from an area of sympatry; secondly, a certain number of hybrids of reptiles of different species is generally known; and thirdly only single hybrids of the first generation have been obtained to the present time. Therefore, the species E. carinatus which has until now been considered to consist of a number of subspecies is, in fact, a complex of species. Neither Paleoasiatic nor African groups can be considered as subspecies and must, therefore, be identified as independent species.

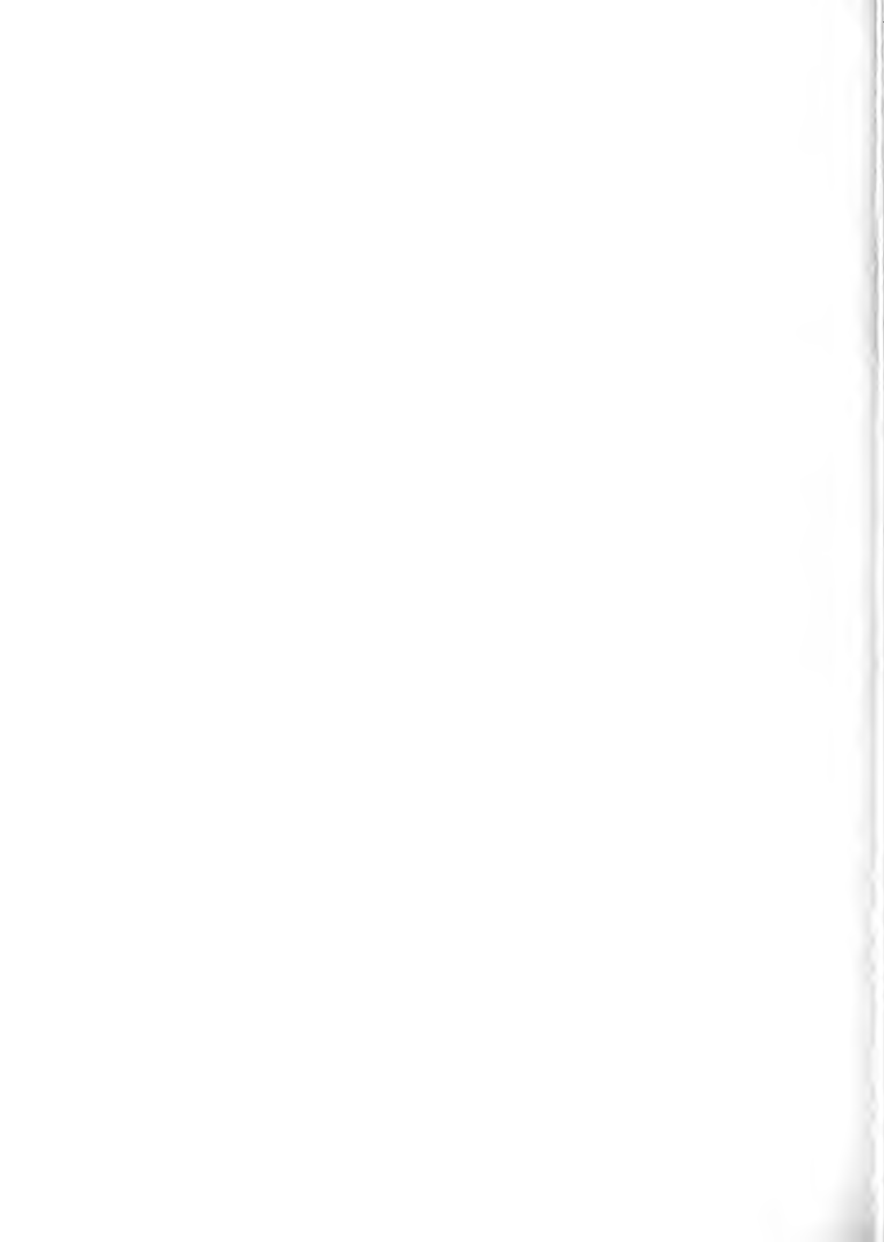
Therefore, we recommend the following taxonomy of snakes of the genus Echis: Paleoasiatic species - E. multisquamatus, E.s. sochureki, E. s. astolae, E.c. coloratus; Indian species - E. c. carinatus, E. c. sinhaleys; African species - E. p. pyramidum, E. p. leakeyi, E. p. aliaborri, E. ocellatus, E. leucogaster.

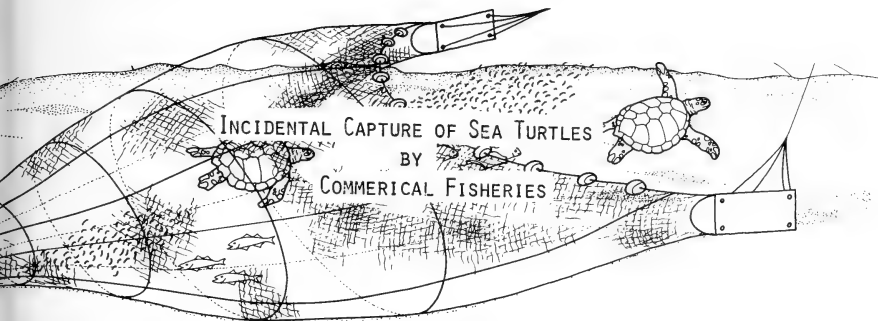
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INTRODUCTION

It is generally agreed (Pritchard, 1980; Mackey, 1980) that overhunting, coupled with a dramatic increase in commercial trade, has decimated sea turtle populations worldwide over the past 2-3 centuries. Now, size alone may render these severely depleted stocks highly vulnerable to a variety of other factors such as water pollution and beach alterations.

One of these additional pressures is the incidental capture (and drowning) of sea turtles by various fishing industries. The fishery that has received the most attention with respect to incidental catch is the shrimping industry (Hillstead et al., 1977; Anonymous, 1976; etc). As a result, the U.S. National Marine Fisheries Service (NMFS) has developed a "trawler efficiency device" (TED) that can be adapted to existing trawl nets (Watson and Seidel, 1980). This device prevents turtles and other large objects from entering the cod end of the trawl.

Much less is known about the incidental catch problem in other fisheries. This report is intended to assess the current state of knowledge and research into the incidental capture of sea turtles by fisheries other than the shrimping industry.

METHODS

The material in this report was obtained primarily by interviewing primary researchers and other individuals likely to be acquainted with the problem. Frequently these people suggested others to contact. Some discussions led to return contacts with the original interviewees. Contacts were made by letter, telephone, and personal interview.

RESULTS

It was universally agreed that there is very little in the way of good documentation of these problems especially in such a form that would allow for the comparison of relative impacts for different fisheries. Still there are several cases where documentation is available. For organizational purposes, these will be dealt with by gear type.

Gill Nets--Large-mesh gill nets, both stationary and drifting, have been implicated in several situations.

1) A clearly documented conflict exists with the large-meshed gill nets set for sturgeon. In Winyah Bay, South Carolina, where these nets are fished throughout the winter, turtle mortalities increased rapidly each year in April (Ulrich, 1978; Marchette, 1981; Hopkins, pers. comm.), presumably as the turtles began to move in towards the feeding and nesting areas. In 1980, the S.C. Wildlife and Marine Resources Department issued regulations closing Winyah Bay to nets with a stretched-mesh larger than 5 inches in mid-April, specifically to reduce sea turtle and bottlenose dolphin mortalities. These mortalities have been significantly reduced,

from ~50/month to 21 and 13 (1980 and 1981 respectively) on North Island (Hopkins, pers. comm.).

Ironically, in April, 1981, some of these displaced South Carolina fishermen obtained a North Carolina out-of-state commercial license and set 1500 yards of stationary 10 inch stretched-mesh gill nets on the Frying Pan Shoals off Smith Island in North Carolina. (Sturgeon fishing has not occurred here for more than 15 years). Within 10 days, between 30 and 47 loggerheads washed up in the immediate vicinity. This constituted ~20% of the total strandings reported in North Carolina in 1981. N.C. Wildlife Enforcement Officer Joseph Newman inspected the nets one day and observed 4 turtles tangled in the nets (Newman, pers. comm.). The obvious relationship between the South Carolina and North Carolina cases was noted by the author while working on this project and the South Carolina information was provided to Officer Newman, who gave a statement at the local public hearings on marine fishing regulations (Newman, 24 February, 1982). The N.C. Division of Marine Fisheries is currently reviewing proposed modifications to its regulations hoping to reduce this conflict. It should be noted that a sturgeon fisherman who sets drift gill nets off the Bogue Banks in North Carolina tends these nets every 1-2 hours, releasing turtles and other incidentally caught species, with little or no mortality (Street, pers. comm.).

2) Balazs (1980) has documented mortality to leatherback turtles due to monofilament drift-nets set for squid in international waters northwest of the Hawaiian Islands. This is a new (1979) fishery, involving nets up to 16km in length and 6m in depth, with a 12cm (bar?) mesh, set overnight by Japanese fishing vessels. Because of the distance from any shore, quantification of mortality here is difficult but a single tuna boat reported "at least 5 dead leatherbacks floating at the surface wrapped in sections of net." Indeed, several tuna boats have become snarled in these nets!

Pound Nets--A number of people mentioned the incidental capture of turtles in a variety of traps. Some of the best documentation of incidental catch outside the shrimping industry has been done on the pound net fishery in Virginia by Molly Lutcavage and Jack Musick at the Virginia Institute of Marine Sciences (Lutcavage, 1981; Musick, 1981). They collected stranding reports on a total of 361 turtles throughout Virginia in 1979 and 1980. Loggerheads were the primary species with a few ridleys and leatherbacks included. Additionally, Lutcavage and Musick contacted many fishermen. They concluded that pound nets were the principle source of turtle mortalities in Virginia during these two years. Interestingly, although turtles do become trapped in the pounds, they are able to breathe here and are usually released, unharmed, by the fisherman. The mortality is caused by entanglement in the large-meshed leaders ("hedges"), frequently well below the surface, where they go unnoticed, and therefore unreleased. These leaders act like infrequently tended large-meshed gill nets.

Although turtles were caught less frequently in smaller-meshed leaders, these tend to foul more readily and are therefore less desirable

to the fishermen. Lutcavage did note (pers. comm.) that leaders that were taut when staked appeared to catch fewer turtles than those that were loosely staked and billowy. She also noticed that catch frequency varied considerably with both location and date, suggesting that the turtles may move in loose aggregations. She suggested that keeping track of these turtle movements and temporarily limiting fishing near concentrations might be a more viable protection alternative than requiring smaller mesh or attempting to release turtles from the extensive, deep leaders.

Shoop (pers. comm.) also reported turtles becoming trapped in pound nets in New York and Rhode Island. Although he has been told some fishermen kill turtles before dumping them, he has no direct evidence of such mortality. In fact, many fishermen cooperated with him and the turtles are tagged before release. He made no mention of entanglement in leaders.

Other Traps--There were also several references to entanglement with lobster traps and crab pots. Two types of mortality are possible here: entanglement in buoy lines below the surface may lead to drowning, and entangled animals may be killed by fishermen as nuisances. Again there is no documentation of mortality rates.

Higman and Davis (1978) reported on the damage done by turtles to spiny lobster gear in the Florida Keys. They presented strong circumstantial evidence that loggerhead turtles cause considerable damage to lobster traps in highly localized areas. This damage appeared to be a result of direct action by the turtles, presumably trying to feed on barnacles growing on the gear and/or the lobsters caught in the traps. Although actual turtle mortality was not investigated, it was noted that damage rates were substantially reduced in areas where the turtles were "removed".

Trawls--Shrimp trawls are a common cause of mortality. This has been studied and reported elsewhere (Hillestad et al., 1977; etc.).

Bullis and Drummond (1978) analyzed 26 years worth of exploratory trawling activities conducted by NMFS research vessels. A total of 53 turtles were taken during 7,625 hours of trawling effort: 41 loggerheads, 7 greens, 4 hawksbills, and 1 leatherback. Although the turtle capture per hour rate was higher for bottomfish trawls than shrimp trawls, it was noted that none of these data came from inside waters, which might have a higher turtle density.

In November, 1980, and December, 1981, there were sharp localized pulses of stranding reports off Pea Island National Wildlife Refuge and Cape Hatteras National Seashore in North Carolina. Schwartz and others attributed this to the winter trawl fishery, primarily for flounder, which has followed the fish south from Virginia at this time of year. Others have suggested that this may be due to a recent major conversion in the king mackerel fishery in this region, from hook-and-line to 6in stretched-mesh gill nets. This situation needs investigation.

An interesting question here is why there are so many turtles in this area at these late dates. Could they be entangled in gill nets while leaving the sounds through Oregon Inlet as the shallower waters cool off? Or are the bottom trawls dragging them from hibernation in soft mud bottoms just offshore? Unconfirmed reports of turtles hibernating in the Cape Lookout Bight have been around for years (Richardson, pers. comm.). Discussion with two geologists indicate the bottom in this area has not been mapped yet.

Lines--A relatively new Japanese longline fishery, set for tuna and swordfish, was mentioned by a number of researchers throughout the southeastern states. Roithmayr (1981) states that NMFS observers estimated 96 turtles were caught by 24 vessels during a three month period (February, March, April) in 1979. Barbara Anderson, of the South Atlantic Fisheries Management Council, indicated to Bricklemeyer (pers. comm.) that they are completing a biological assessment on this situation for the swordfish fishery and will soon initiate formal consultation under Section 7 of the Endangered Species Act.

Shoop noted (pers. comm.) hearsay reports of turtles caught by longlines set for sharks. And George Balazs has recently finished an annotated bibliography of longline/sea turtle interactions.

Hildebrand (1980) reports that green turtles were frequently "caught" (usually foul hooked in the flipper) on trotlines set in eel grass flats in the Laguna Madre, Texas. Reports decreased after 1976, correlating to a drop in the number of trotlines and a change in the area fished.

Bricklemeyer (pers. comm.) reported that Barbara Anderson has also received hearsay reports of turtles taken in the hook-and-line fishery for snapper and grouper.

Seines--Schwartz (pers. comm.) states turtles are often caught in menhaden purse seines, as did Carr (pers. comm.) and Shoop (pers. comm.). Schwartz likewise mentioned tuna purse seines. Documentation is not available for these reports. Shoop also received a report of a leatherback caught twice in the same day in salmon purse seines off the west coast of Canada, August, 1981. There was a large concentration of jellyfish in the area. The turtle was tagged and released unharmed.

A single loggerhead and two diamondback terrapins were reported form 61 longhaul seine catches in the sounds and estuaries in North Carolina (DeVries, 1980). But Johnson (pers. comm.) reported "many" caught. He was unsure about mortality. Clearly the situation with seines is muddy.

Dredges--Even though dredges are used for fishing for scallops, oysters, and clams, the clearly documented conflict with turtles is with channel maintenance dredges in the Port Canaveral Shipping Channel (Pritchard, 1981). This unfortunate situation seems to result from the

recently discovered hibernation of turtles in the soft mud sides of the channel (Carr et al., 1980). It has been mentioned that hibernation has been rumored but not documented elsewhere. It is unknown whether shellfish dredges have the potential to disturb or kill such turtles if they exist.

SUMMARY, DISCUSSION AND CONCLUSIONS

In summary, there is at least hearsay indication of conflict between turtles and all the major classes of fishing gear. Yet, aside from the shrimping industry, these conflicts have been clearly documented in only a few situations. There is even less evidence available on mortality rates. Nevertheless some conclusions can be made.

There is a clear conflict between turtles and large-meshed gill nets. This has been documented with sturgeon nets in North and South Carolina, squid drift nets in the Pacific Ocean, and the leaders to certain pound nets in Virginia.

The relatively new offshore longline fishery for tuna and billfish (swordfish, etc.) may pose a significant threat. As noted, George Balazs is preparing an annotated bibliography on longline/turtle conflicts and the South Atlantic Fishery Management Council is preparing a biological assessment of this situation in the swordfish industry.

There are several other situations that need investigation. Is the November/December mortality off Cape Hatteras, North Carolina due to the winter trawl fishery for bottom fish, the recent switch to gill nets in the king mackerel fishery, or is this unrelated to fishing? Could this be a natural biological phenomenon such as cold stunning? Why are turtles present here at this time of year? Menhaden purse seines were implicated by many, but no documentation was found. Is this an oversight?

Several other conclusions can be made from this study. Fishery trends are dynamic. As the world demand for fish and energy costs increase, new equipment and even new fisheries are being introduced. This is illustrated clearly in a North Carolina Division of Marine Fisheries report entitled Trends in North Carolina's Commercial Fisheries, 1965-1980 (Street, 1981). Balazs (1982) notes the squid driftnet fishery only started in 1979. The Japanese longline fishery off Texas is also very recent. The North Carolina gill net take for king mackerel increased from 0 pounds in 1978 to 124,800 pounds in 1981 and there is a growing pound net fishery in the Pamlico Sound in North Carolina (Street, pers. comm.). George Henderson (pers. comm.) mentioned a new deep-water roller-trawl fishery off Georgia. If turtles are overwintering in the offshore reefs there (Richardson, pers. comm.), they may be affected by this gear.

In addition to being innovative, approaches to sea turtle/fisheries conflicts will have to be flexible. As Lutcuage suggested, monitoring

turtle movements and closing local areas for short periods may be more fruitful in some situations than redesigning gear. Likewise, as Shoop noted, a widespread, intensive, information program for fishermen is very important, especially in the live entanglement situations.

The number and type of conflicts vary geographically. North Carolina's waters are biogeographically complex. There are both northern and southern fisheries as well as the tremendous sound systems. The South Carolina and Georgia fisheries are much less diverse, with shrimping being a primary fishery and a primary cause of turtle mortality. Florida, with temperate and subtropical waters, and both the Atlantic and the Gulf of Mexico, might also be expected to have a diversity of fisheries and turtle conflicts.

What information there is on sea turtle/fishery conflicts (outside the well documented shrimping industry) is widely scattered. Even within a single agency, such as NMFS, repeated contacts with a variety of persons yielded more information. The author's location in North Carolina lent itself to a more thorough investigation of the North Carolina information. This should be done in the other states as well.

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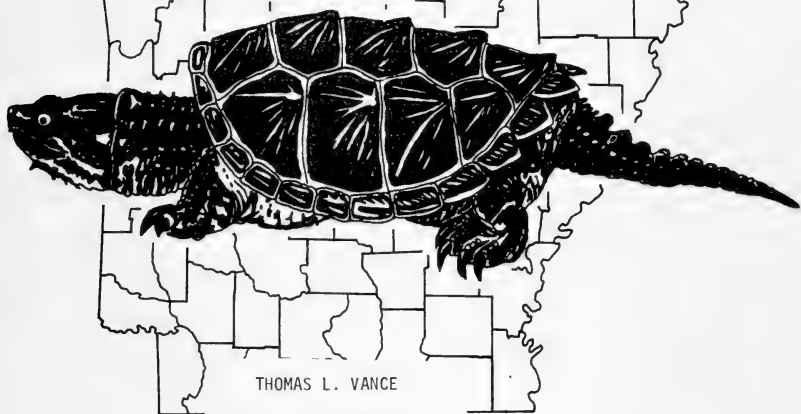
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ANNOTATED CHECKLIST
AND
BIBLIOGRAPHY
OF
ARKANSAS REPTILES



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Annotated Checklist and Bibliography of the Reptiles of Arkansas

Introduction

This report is concerned with all available literature regarding the reptilian fauna of Arkansas. Methods for obtaining these sources were scattered and varied, but appear to be relatively complete through the summer of 1983. Each citation is numbered and cross-indexed according to each appropriate taxon of the checklist.

Actual physiological research is scarce; however, most reports, which are not of a generalized nature, deal primarily with locality data and distribution. This is of a major concern for two reasons. First, Arkansas appears to be a geographic melting pot containing an assemblage of taxa which converge from the northern, southern, eastern and western versants of the United States. Some of the resulting areas of subspecific intergradation pose serious taxonomic problems. Second, many of the early publications resulting from the early railroad surveys report collecting data from the "Arkansas Territory." Today, this territory is inclusive of portions of Oklahoma, Kansas and Missouri. Hence, many records are of an extralimital nature.

In order to be of assistance to future researchers, the checklist is broken down into three primary sections: native taxa, extralimital and problematical reports, and the fossil record. The native taxa are those which are currently understood to range into Arkansas. It is divided into several subsections (when applicable) to enhance the accessibility of an appropriate article. The general subsection includes only reports which map or provide general information in reference to the state.

The listing in the specific locality data subsection provides access to reports which provide specific localities. If the article is concerned with ecology or behavior, it is then placed under either category. A number of references cause or remedy systematic problems and are placed under this subsection. Finally, the native taxa lists references of a miscellaneous nature.

The second category involves taxa and locality reports which are extralimital or doubtful. It includes misidentified species and subspecies, escapees, and records from areas other than Arkansas.

The final list includes the fossil records. Found within it are reports of extinct reptiles and fossil evidence of current existing species.

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Native Taxa

Agkistrodon contortrix

General: 5, 19, 24, 52, 85, 92, 100, 112, 114, 117, 185, 214, 232, 233, 240, 251, 281, 308, 309, 315, 322, 388.

Systematic Problems: 232, 386.

Other: 281.

Agkistrodon contortrix contortrix

General: 2, 20, 43, 75, 79, 91, 100, 113, 154, 155, 189, 228, 287, 288, 302, 361, 386, 387.

Specific Locality Data: 109, 118, 188, 227, 229, 252, 253, 255, 256, 290, 293, 296, 314, 325, 327, 336, 357, 387, 391.

Ecological Data: 227, 252, 256, 293, 387.

Behavioral Data: 293.

Systematic Problems: 2, 52, 85, 118, 154, 155, 287, 288, 293, 296, 302, 386, 387.

Other: 189, 253, 293, 361, 391.

Agkistrodon piscivorus

General: 5, 24, 100, 113, 196, 240, 281, 284, 315.

Other: 281.

Agkistrodon piscivorus leucostoma

General: 20, 54, 91, 117, 165, 175, 189, 287, 288, 302, 308, 309, 320, 361, 386, 387.

Specific Locality Data: 15, 58, 100, 106, 109, 118, 133, 188, 229, 252, 253, 255, 256, 290, 293, 296, 325, 327, 336.

Ecological Data: 54, 58, 175, 252, 293, 327, 336.

Behavioral Data: 293, 336.

Other: 189, 253, 293, 361.

Alligator mississippiensis

General: 24, 39, 45, 74, 81, 91, 143, 169, 197, 204, 228, 240, 245, 265, 287, 296, 312, 323, 361, 364, 390.

Specific Locality Data: 6, 28, 39, 102, 109, 118, 171, 197, 245, 268, 289, 291, 296.

Ecological Data: 39, 140, 171, 245, 268, 296, 343.

Anolis carolinensis

General: 19, 24, 27, 68, 79, 82, 91, 117, 161, 240, 287, 306, 308, 309, 323, 343, 361, 364.

Specific Locality Data: 3, 58, 109, 118, 188, 195, 255, 256, 293, 296, 325, 327, 336.

Ecological Data: 3, 27, 58, 256, 327.

Behavioral Data: 3, 327.

Other: 195, 327, 361.

Carphophis amoenus

General: 19, 24, 33, 187, 240, 308, 309, 315.

Carphophis amoenus helenae

General: 19, 361.

Specific Locality Data: 225.

Systematic Problems: 229.

Other: 361.

Carphophis amoenus vermis

General: 32, 76, 77, 91, 103, 113, 117, 185, 288, 302, 361, 367, 386, 387.

Specific Locality Data: 76, 109, 118, 126, 188, 229, 252, 255, 278, 290, 293, 296, 324, 327, 336, 354.

Ecological Data: 126, 252.

Systematic Problems: 229, 278.

Other: 126, 293, 361.

Cemophora coccinea

General: 5, 19, 24, 196, 240, 315, 323, 349, 386, 387.

Cemophora coccinea copei

General: 20, 91, 117, 361, 377, 378.

Specific Locality Data: 2, 63, 65, 109, 118, 246, 251, 252, 268, 296, 378.

Ecological Data: 65, 246, 252, 268.

Behavioral Data: 65.

Other: 65, 361, 377, 378.

Chelydra serpentina

General: 19, 24, 46, 85, 117, 130, 134, 240, 318, 319, 364, 375.

Chelydra serpentina serpentina

General: 20, 73, 91, 127, 134, 308, 309, 315, 361, 367.

Specific Locality Data: 106, 109, 118, 188, 229, 252, 290, 293, 296, 308, 309, 325, 327, 336.

Ecological Data: 106, 134, 252, 293.

Behavioral Data: 293.

Systematic Problems: 229.

Other: 134, 293, 361.

Chrysemys picta

General: 19, 24, 26, 62, 130, 240, 308, 309, 315, 318, 319, 364, 367, 375.

Other: 62.

Chrysemys picta dorsalis

General: 20, 37, 73, 79, 91, 129, 361.

Specific Locality Data: 109, 118, 127, 128, 129, 188, 235, 252, 293, 296, 336.

Ecological Data: 129, 252.

Behavioral Data: 129.

Systematic Problems: 26, 118, 127, 128, 129, 188.

Other: 129, 235, 361.

Chrysemys picta marginata

General: 20.

Specific Locality Data: 118.

Systematic Problems: 26, 118, 127, 128.

Cnemidophorus

General: 364.

Cnemidophorus sexlineatus

General: 15, 19, 20, 24, 46, 57, 58, 117, 122, 240, 306, 308, 309, 315, 318, 319, 343, 367.

Specific Locality Data: 139, 188, 249, 345, 350, 388.

Ecological Data: 343, 345, 350.

Cnemidophorus sexlineatus sexlineatus

General: 20, 91, 100, 306, 319, 355, 361.

Specific Locality Data: 15, 57, 58, 60, 61, 100, 109, 118, 122, 139, 147, 188, 251, 252, 255, 290, 293, 296, 327, 336, 351.

Ecological Data: 58, 252, 327.

Behavioral Data: 58, 139, 336.

Systematic Problems: 15, 46, 57, 58, 109, 118, 122, 139, 188, 249, 290, 293, 306, 327, 336, 388.

Other: 361.

Cnemidophorus sexlineatus viridis

General: 20, 306, 319, 355, 361.

Specific Locality Data: 15, 57, 58, 109, 118, 126, 188, 229, 290, 293, 296, 336, 345, 351, 363.

Ecological Data: 345.

Systematic Problems: 15, 46, 57, 58, 109, 118, 126, 139, 188, 229, 249, 290, 293, 306, 336, 345, 388.

Other: 361, 363.

Coluber constrictor

General: 5, 19, 24, 33, 46, 100, 117, 177, 240, 308, 309, 315, 319, 364, 375, 382.

Specific Locality Data: 229.

Systematic Problems: 229.

Coluber constrictor anthicus

General: 7, 20, 81, 91, 211, 287, 361, 379, 382, 387.

Specific Locality Data: 109, 118, 120, 379.

Systematic Problems: 46, 109, 118, 379.

Other: 361.

Coluber constrictor flaviventris

General: 2, 7, 20, 81, 85, 91, 215, 248, 288, 302, 319, 361, 379, 382, 386, 387.

Specific Locality Data: 7, 58, 109, 118, 188, 248, 293, 296.

Ecological Data: 293.

Systematic Problems: 7, 33, 46, 100, 109, 118, 188, 288, 293, 387, 379.

Other: 293, 361.

Coluber constrictor priapus

General: 7, 20, 91, 100, 288, 302, 315, 361, 366, 382, 386, 387.
 Specific Locality Data: 7, 58, 100, 109, 118, 188, 252, 255, 256, 290, 293, 296, 325, 327, 336, 358, 382.
 Ecological Data: 58, 252.
 Behavioral Data: 293.
 Systematic Problems: 7, 33, 46, 100, 109, 118, 188, 252, 288, 293, 315, 366, 379, 387.
 Other: 293, 361.

Crotalus atrox

General: 2, 19, 24, 51, 52, 68, 79, 91, 112, 113, 117, 153, 167, 170, 209, 233, 238, 266, 281, 287, 288, 300, 302, 308, 309, 313, 318, 353, 361, 368, 386, 387, 396, 397.
 Specific Locality Data: 2, 109, 118, 253, 255, 256, 293, 296, 387.
 Ecological Data: 256, 293, 387.
 Behavioral Data: 256, 293, 387.
 Other: 253, 281, 293, 361.

Crotalus horridus

General: 2, 5, 19, 20, 24, 43, 46, 52, 84, 85, 91, 92, 100, 113, 117, 153, 170, 175, 185, 188, 189, 209, 215, 240, 281, 287, 288, 302, 308, 309, 315, 320, 327, 361, 353, 367, 386, 387, 388, 394.
 Specific Locality Data: 15, 52, 84, 109, 118, 153, 188, 209, 234, 252, 253, 255, 256, 257, 290, 293, 296, 324, 325.
 Ecological Data: 92, 252, 256, 293.
 Behavioral Data: 256.
 Systematic Problems: 2, 15, 118, 170, 257, 281, 287, 288, 353, 386, 387.
 Other: 189, 234, 253, 281, 293, 361, 387.

Crotaphytus collaris

General: 19, 24, 55, 59, 81, 164, 168, 176, 187, 265, 271, 308, 309, 318, 319, 343, 364, 383.

Crotaphytus collaris collaris

General: 2, 13, 55, 79, 91, 117, 138, 142, 287, 306, 322, 330, 344, 361, 389.
 Specific Locality Data: 15, 55, 58, 109, 112, 145, 187, 188, 220, 221, 223, 229, 236, 255, 290, 293, 296, 343, 346, 347, 388.
 Ecological Data: 187, 220, 221, 223, 343, 346.
 Behavioral Data: 187, 221, 343.
 Other: 55, 229, 236, 330, 344, 346, 347, 361.

Deirochelys reticularia

General: 19, 24, 130, 240, 263, 287, 392.
 Specific Locality Data: 293.
 Systematic Problems: 293.

Deirochelys reticularia miaria

General: 2, 73, 79, 91, 295, 361, 374.
 Specific Locality Data: 109, 118, 295, 336.
 Systematic Problems: 109, 118, 295.
 Other: 361.

Deirochelys reticularia reticularia

Specific Locality Data: 109, 118, 296.

Systematic Problems: 109, 118.

Diadophis

General: 364.

Diadophis punctatus

General: 5, 19, 24, 33, 117, 147, 240, 308, 309, 315, 318, 319, 323, 367, 387.

Specific Locality Data: 126, 188, 325.

Ecological Data: 126.

Systematic Problems: 188, 325.

Diadophis punctatus arnyi

General: 20, 31, 34, 91, 112, 113, 148, 185, 287, 288, 302, 319, 322, 361, 386, 387.

Specific Locality Data: 34, 58, 109, 118, 188, 255, 290, 293, 296, 324, 387.

Systematic Problems: 58, 117, 118, 147, 151, 188, 293.

Other: 293, 361, 387.

Diadophis punctatus stictogenys

General: 20, 34, 91, 113, 302, 361, 386, 387.

Specific Locality Data: 34, 58, 109, 118, 188, 227, 252, 293, 296, 327.

Ecological Data: 227.

Systematic Problems: 58, 117, 118, 147, 151, 188, 293, 327.

Other: 293, 361.

Elaphe guttata

General: 5, 19, 24, 100, 117, 184, 187, 188, 240, 308, 309, 315, 318, 319, 364, 386.

Specific Locality Data: 256, 293, 313.

Systematic Problems: 313, 319.

Elaphe guttata emoryi

General: 17, 20, 91, 113, 302, 361, 385, 386, 387.

Specific Locality Data: 14, 58, 100, 109, 118, 162, 187, 188, 296.

Systematic Problems: 14, 17, 58, 100, 109, 118, 187, 188, 293, 386.

Other: 361.

Elaphe guttata guttata

General: 20, 75, 91, 116, 228, 361, 386, 387.

Specific Locality Data: 109, 118, 187, 188.

Systematic Problems: 100, 109, 118, 187, 188, 293, 302, 386, 387.

Other: 361.

Elaphe obsoleta

General: 5, 19, 24, 46, 100, 117, 240, 244, 308, 309, 315.

Specific Locality Data: 229, 237.

Systematic Problems: 229.

Other: 237.

Elaphe obsoleta lindheimeri

General: 20, 91, 97, 107, 112, 302, 361, 386, 387.

Specific Locality Data: 109, 118, 188, 293, 336.

Systematic Problems: 46, 109, 112, 118, 188, 293, 386, 387.

Other: 361.

Elaphe obsoleta obsoleta

General: 2, 20, 85, 91, 112, 215, 287, 302, 361, 367, 386, 387.

Specific Locality Data: 10, 11, 12, 23, 58, 109, 118, 133, 188, 214, 227, 252, 256, 290, 293, 296, 327, 336.

Ecological Data: 227, 252.

Systematic Problems: 2, 46, 109, 112, 118, 133, 188, 214, 256, 287, 327, 387.

Other: 10, 11, 12, 23, 361.

Eumeces

General: 364.

Eumeces anthracinus

General: 19, 24, 187, 239, 240, 306, 322, 337, 343.

Eumeces anthracinus pluvialis

General: 20, 91, 117, 228, 287, 305, 308, 309, 317, 326, 337, 361.

Specific Locality Data: 9, 58, 61, 109, 118, 188, 255, 290, 293, 296, 306, 308, 309, 317, 327, 336, 337, 356.

Ecological Data: 9, 327.

Behavioral Data: 327.

Other: 58, 61, 308, 309, 327, 337, 361.

Eumeces fasciatus

General: 19, 20, 24, 46, 56, 85, 91, 117, 137, 240, 306, 308, 309, 315, 337, 343, 361, 367.

Specific Locality Data: 15, 58, 100, 109, 118, 174, 188, 195, 220, 227, 229, 249, 252, 255, 290, 293, 296, 324, 325, 327, 331, 336, 337, 388.

Ecological Data: 56, 58, 137, 220, 227, 252, 327, 331.

Behavioral Data: 327.

Systematic Problems: 15, 58, 100, 109, 118, 188, 229, 293, 324, 325, 327, 331, 337, 388.

Other: 58, 137, 174, 195, 293, 327, 336, 337, 361.

Eumeces laticeps

General: 19, 20, 24, 85, 91, 137, 240, 306, 315, 337, 343, 361.

Specific Locality Data: 15, 58, 100, 109, 118, 188, 205, 220, 229, 252, 293, 296, 306, 324, 325, 327, 335, 336, 337.

Ecological Data: 137, 220, 252, 327, 336.

Systematic Problems: 15, 58, 100, 109, 118, 188, 229, 293, 324, 325, 327.

Other: 205, 293, 327, 335, 337, 361.

Eumeces obsoletus

General: 337.

Specific Locality Data: 274, 337.

Eumeces septentrionalis

General: 19, 24.

Eumeces septentrionalis obtusirostris

General: 91, 361.

Specific Locality Data: 268, 296.

Ecological Data: 268.

Other: 361.

Farancia abacura

General: 5, 19, 24, 187, 240, 315, 323.

Farancia abacura reinwardti

General: 20, 91, 302, 303, 361, 386, 387.

Specific Locality Data: 58, 109, 118, 143, 188, 252, 293, 296, 303, 328, 336.

Ecological Data: 58, 252, 293.

Behavioral Data: 143.

Other: 293, 361.

Graptemys

Specific Locality Data: 67, 339.

Ecological Data: 339.

Graptemys geographica

General: 1, 19, 20, 21, 24, 46, 51, 73, 79, 85, 91, 130, 179, 187, 211, 239, 240, 263, 308, 309, 315, 361, 364, 367.

Specific Locality Data: 106, 109, 118, 188, 199, 200, 290, 293, 308, 309, 336.

Ecological Data: 106.

Other: 199, 308, 309, 361.

Graptemys kohnii

General: 19, 20, 24, 69, 72, 73, 91, 123, 130, 361.

Specific Locality Data: 72, 106, 173, 296, 339.

Ecological Data: 106, 339.

Systematic Problems: 188, 367.

Other: 361.

Graptemys pseudogeographica

General: 130, 239, 240, 263, 308, 309, 315, 364.

Graptemys pseudogeographica ouachitensis

General: 19, 46, 73, 91, 117, 123, 287, 361, 367.

Specific Locality Data: 61, 109, 118, 188, 252, 293, 296, 336, 339.

Ecological Data: 252, 339.

Systematic Problems: 188, 252, 263, 287, 293, 367.

Other: 361.

Heterodon

General: 364.

Heterodon nasicus gloydi

General: 17, 144, 164, 318, 361.

Specific Locality Data: 230.

Systematic Problems: 386.

Other: 361.

Heterodon platyrhinos

General: 5, 19, 20, 24, 38, 46, 85, 91, 117, 125, 215, 240, 302, 308, 309, 315, 318, 361, 367, 386, 387.

Specific Locality Data: 38, 58, 109, 118, 188, 229, 252, 255, 256, 290, 293, 296, 325, 327, 336, 348, 359.

Ecological Data: 58, 252, 348.

Behavioral Data: 293.

Other: 125, 293, 361.

Kinosternon

General: 364.

Kinosternon subrubrum

General: 19, 24, 92, 130, 135, 240, 316, 323.

Specific Locality Data: 193, 216.

Ecological Data: 216.

Other: 193.

Kinosternon subrubrum hippocrepis

General: 2, 20, 73, 91, 93, 190, 263, 272, 287, 361.

Specific Locality Data: 109, 188, 190, 252, 293, 297, 336.

Ecological Data: 252.

Systematic Problems: 91, 188, 297.

Other: 361.

Kinosternon subrubrum subrubrum

General: 20, 91.

Specific Locality Data: 188.

Systematic Problems: 91, 188.

Lampropeltis

General: 364.

Lampropeltis calligaster

General: 5, 19, 24, 68, 97, 107, 113, 117, 185, 240, 308, 309, 315, 318, 323, 386.

Lampropeltis calligaster calligaster

General: 2, 20, 36, 91, 94, 218, 287, 302, 361, 387.

Specific Locality Data: 30, 36, 58, 61, 109, 118, 188, 224, 252, 255, 256, 293, 296, 336, 387.

Ecological Data: 224, 293.

Behavioral Data: 61.

Systematic Problems: 107.

Other: 36, 293, 361, 387.

Lampropeltis getulus

General: 5, 24, 117, 240, 299, 308, 309, 315, 319, 100.

Lampropeltis getulus holbrooki

General: 2, 19, 20, 35, 42, 50, 91, 100, 112, 113, 177, 218, 287, 288, 318, 361, 386, 387.

Specific Locality Data: 30, 35, 58, 109, 118, 188, 227, 249, 252, 255, 256, 290, 293, 296, 325, 327, 336, 387.

Ecological Data: 58, 227, 252, 336.

Behavioral Data: 293.

Systematic Problems: 386.

Other: 293, 361, 387.

Lampropeltis triangulum

General: 19, 24, 46, 97, 117, 147, 148, 188, 240, 308, 309, 315, 318, 319, 364.

Specific Locality Data: 229.

Systematic Problems: 229.

Lampropeltis triangulum amaura

General: 79, 81, 91, 112, 113, 172, 218, 287, 288, 302, 361, 376, 386, 387.

Specific Locality Data: 8, 30, 109, 118, 188, 296, 325, 327, 376.

Ecological Data: 8.

Behavioral Data: 327.

Systematic Problems: 97, 109, 112, 118, 188, 287, 288, 325, 376.

Other: 361.

Lampropeltis triangulum syspila

General: 2, 29, 33, 91, 94, 112, 113, 218, 287, 288, 302, 361, 376, 386, 387.

Specific Locality Data: 30, 109, 118, 188, 252, 293, 296, 324, 325, 376, 387.

Ecological Data: 293.

Behavioral Data: 293.

Systematic Problems: 97, 109, 112, 118, 188, 287, 288, 324, 325.

Other: 293, 361, 387.

Macroclemys temminckii

General: 19, 20, 24, 73, 91, 117, 130, 131, 228, 240, 263, 308, 309, 315, 361.

Specific Locality Data: 109, 188, 252, 263, 293, 308, 309, 336.

Ecological Data: 131, 252.

Other: 293, 308, 309, 361.

Masticophis flagellum

General: 5, 19, 24, 117, 187, 240, 315, 380, 381.

Masticophis flagellum flagellum

General: 2, 20, 91, 109, 287, 302, 308, 309, 318, 319, 361, 380, 381, 386, 387.

Specific Locality Data: 58, 109, 118, 188, 229, 249, 255, 256, 290, 293, 296, 336, 381, 387.

Ecological Data: 58, 256, 293.

Behavioral Data: 387.

Other: 293, 361, 380.

Micrurus fulvius

General: 5, 9, 24, 81, 100, 160, 196, 213, 232, 233, 240, 281, 302, 323, 388.

Other: 281.

Micrurus fulvius tenere

General: 2, 5, 52, 79, 91, 188, 280, 281, 287, 288, 361, 368, 386, 387.

Specific Locality Data: 109, 253, 273, 296, 371.

Systematic Problems: 281, 296.

Other: 361.

Nerodia

General: 364.

Nerodia cyclopion

General: 5, 19, 24, 187, 240, 302, 315, 323.

Nerodia cyclopion cyclopion

General: 20, 79, 91, 156, 361, 386, 387.

Specific Locality Data: 109, 118, 156, 187, 188, 252, 255, 293, 296.

Ecological Data: 187.

Behavioral Data: 187.

Systematic Problems: 109.

Other: 361.

Nerodia erythrogaster

General: 5, 19, 85, 92, 117, 240, 308, 309, 315, 318.

Nerodia erythrogaster flavigaster

General: 5, 20, 49, 85, 86, 91, 113, 187, 302, 361, 386, 387.

Specific Locality Data: 11, 12, 15, 58, 105, 109, 110, 118, 146, 247, 252, 293, 296, 327, 336, 387.

Ecological Data: 105, 110, 252.

Systematic Problems: 15, 49, 58, 86, 91, 109, 110, 118, 252, 293, 327, 387.

Other: 11, 12, 149, 361, 387.

Nerodia erythrogaster transversa

General: 17, 20, 33, 49, 81, 86, 91, 112, 187, 302, 319, 322, 361, 365, 386, 387.

Specific Locality Data: 13, 15, 58, 61, 100, 109, 110, 118, 188, 219, 229, 252, 256, 293, 296, 325, 336.

Ecological Data: 58, 110, 252.

Systematic Problems: 15, 17, 49, 58, 86, 89, 91, 100, 109, 110, 118, 188, 219, 229, 252, 256, 293.

Other: 361.

Nerodia fasciata

General: 5, 19, 24, 89, 187, 240.

Specific Locality Data: 188.

Nerodia fasciata confluens

General: 2, 20, 78, 89, 91, 94, 113, 287, 288, 292, 361, 386, 387.

Specific Locality Data: 11, 12, 64, 89, 109, 118, 124, 149, 188, 252, 255, 293, 296, 325, 327, 336.

Ecological Data: 252, 336.

Systematic Problems: 109, 118, 188, 255, 288, 292, 293, 386.

Other: 11, 12, 64, 124, 149, 361.

Nerodia rhombifera rhombifera

General: 17, 19, 20, 24, 91, 113, 117, 187, 240, 287, 302, 308, 309, 315, 334, 361, 386, 387.

Specific Locality Data: 10, 11, 12, 109, 118, 149, 188, 229, 232, 237, 252, 255, 256, 293, 296, 327, 336.

Ecological Data: 252, 327.

Other: 10, 11, 12, 149, 237, 361.

Nerodia sipedon

General: 5, 19, 24, 33, 46, 85, 89, 117, 240, 264, 308, 309, 315, 318, 319, 323.

Nerodia sipedon pleuralis

General: 2, 20, 78, 81, 89, 91, 287, 288, 292, 302, 361, 386, 387, 388.

Specific Locality Data: 58, 61, 89, 109, 110, 118, 188, 229, 249, 270, 290, 293, 336.

Ecological Data: 58, 61, 110, 270, 293.

Behavioral Data: 58, 61, 293.

Systematic Problems: 3, 58, 109, 118, 188, 229, 249, 288, 292, 293, 336, 388.

Other: 293, 361.

Nerodia sipedon sipedon

General: 386, 387.

Specific Locality Data: 296, 388.

Systematic Problems: 296, 388.

Opheodrys

General: 364.

Opheodrys aestivus

General: 5, 19, 20, 24, 85, 91, 100, 117, 240, 254, 302, 308, 309, 315, 319, 361, 386, 387, 398.

Specific Locality Data: 15, 58, 100, 103, 109, 115, 118, 159, 188, 227, 229, 252, 259, 260, 261, 262, 290, 293, 296, 325, 327, 336, 388, 399.

Ecological Data: 58, 115, 227, 252, 260, 261, 262, 293, 399.

Behavioral Data: 260, 261.

Systematic Problems: 15, 293.

Other: 103, 115, 259, 262, 293, 361.

Ophisaurus

General: 364.

Ophisaurus attenuatus

General: 19, 24, 117, 132, 240, 306, 315, 343.

Ophisaurus attenuatus attenuatus

General: 19, 20, 180, 224, 361.

Specific Locality Data: 100, 109, 188, 224, 229, 256, 293, 296, 343.

Ecological Data: 224.

Systematic Problems: 100, 109, 188, 229, 256, 293, 306, 308, 309.

Other: 293, 361.

Phrynosoma

General: 364.

Phrynosoma cornutum

General: 18, 19, 21, 24, 25, 40, 47, 59, 68, 75, 79, 91, 95, 100, 112, 117, 157, 164, 168, 269, 287, 301, 306, 318, 319, 361.

Specific Locality Data: 100, 109, 188, 269, 293, 296.

Ecological Data: 109.

Other: 361.

Pituophis melanoleucus

General: 240, 264, 302, 308, 309, 315.

Pituophis melanoleucus sayi

General: 2, 20, 113, 208, 232, 287, 288, 318, 319, 332, 361, 375, 386, 387.

Specific Locality Data: 109, 188, 293, 296, 333.

Systematic Problems: 109.

Other: 361.

Pseudemys

Specific Locality Data: 339.

Ecological Data: 339.

Pseudemys concinna

General: 19, 24, 130, 240, 315, 319, 394.

Pseudemys concinna concinna

General: 1, 20, 91, 361.

Specific Locality Data: 106, 188, 296, 325.

Ecological Data: 106.

Behavioral Data: 106.

Systematic Problems: 106, 188.

Other: 361.

Pseudemys floridana

General: 19, 24, 117, 130, 240, 318, 394.

Pseudemys floridana hoyi

General: 20, 73, 91, 239, 308, 309, 361.

Specific Locality Data: 53, 73, 106, 118, 203, 252, 296, 308, 309.

Ecological Data: 106.
 Behavioral Data: 106.
 Systematic Problems: 252.
 Other: 73, 308, 309, 361.

Pseudemys scripta

General: 19, 24, 117, 130, 131, 240, 251, 315, 318, 319, 322.

Pseudemys scripta elegans

General: 20, 66, 73, 85, 91, 136, 251, 263, 308, 309, 361, 364.
 Specific Locality Data: 60, 70, 71, 106, 109, 118, 136, 158, 188, 222, 252, 293, 296, 327, 336, 339.
 Ecological Data: 66, 106, 136, 222, 252, 293, 336, 339.
 Behavioral Data: 263, 336.
 Systematic Problems: 85, 109, 251, 252, 293.
 Other: 158, 361.

Regina grahamii

General: 19, 24, 91, 117, 302, 308, 309, 315, 361, 386, 387.
 Specific Locality Data: 109, 118, 188, 251, 252, 256, 268, 293, 296.
 Ecological Data: 268.
 Behavioral Data: 268.
 Other: 268.

Regina rigida

General: 5, 19, 24, 302, 323, 387.

Regina rigida sinicola

General: 91, 186, 240, 331, 361.
 Specific Locality Data: 109, 118, 186, 268, 296.
 Ecological Data: 186, 268.
 Behavioral Data: 268.
 Systematic Problems: 186, 296, 386.
 Other: 361.

Regina septemvittata

General: 2, 5, 19, 20, 24, 79, 81, 87, 91, 117, 213, 215, 232, 240, 268, 315, 361, 386, 387.
 Specific Locality Data: 87, 109, 118, 188, 258, 268, 293, 296, 326, 327.
 Ecological Data: 87, 268.
 Behavioral Data: 268.
 Systematic Problems: 87, 188, 326, 327.
 Other: 87, 327, 361.

Sceloporus

General: 364.

Sceloporus undulatus

General: 19, 24, 56, 85, 100, 176, 240, 306, 315, 319.

Sceloporus undulatus hyacinthinus

General: 20, 80, 91, 100, 117, 304, 306, 308, 309, 330, 361.

Specific Locality Data: 44, 58, 60, 61, 100, 109, 188, 195, 220, 227, 229, 249, 252, 290, 293, 296, 324, 325, 327, 333, 336, 384.

Ecological Data: 58, 61, 220, 227, 252, 327, 384.

Behavioral Data: 61, 327.

Systematic Problems: 109, 188, 293, 304, 306, 327.

Other: 56, 58, 80, 100, 195, 327, 330, 361.

Scincella lateralis

General: 19, 20, 24, 48, 56, 85, 91, 117, 212, 240, 306, 308, 209, 315, 361.

Specific Locality Data: 48, 58, 60, 61, 109, 118, 142, 188, 195, 227, 249, 252, 255, 290, 293, 296, 306, 308, 309, 324, 325, 327, 336.

Ecological Data: 58, 61, 142, 227, 252, 327.

Other: 56, 142, 195, 293, 327, 336, 361.

Sistrurus miliarius

General: 5, 24, 33, 68, 100, 114, 117, 187, 213, 240, 281, 320, 322.

Other: 281.

Sistrurus miliarius streckeri

General: 20, 91, 94, 112, 113, 153, 170, 189, 209, 241, 250, 281, 287, 288, 300, 302, 308, 309, 361, 353, 368, 386, 387, 397.

Specific Locality Data: 15, 51, 100, 109, 118, 152, 153, 167, 170, 188, 209, 250, 252, 287, 290, 293, 296, 308, 309, 327, 336, 353, 368, 397.

Ecological Data: 293.

Behavioral Data: 241.

Other: 189, 241, 252, 293, 361, 353.

Sonora episcopa

General: 19, 24, 81, 302, 318, 319.

Sonora episcopa episcopa

General: 79, 91, 361.

Specific Locality Data: 268, 296.

Ecological Data: 268.

Other: 361.

Sternotherus

General: 364.

Sternotherus carinatus

General: 19, 24, 68, 73, 79, 91, 93, 130, 191, 211, 263, 287, 298, 340, 341, 361.

Specific Locality Data: 106, 109, 188, 191, 201, 216, 239, 255, 293, 296, 336, 340.

Ecological Data: 106, 216.

Behavioral Data: 106.

Other: 106, 361.

Sternotherus odoratus

General: 19, 20, 24, 73, 85, 91, 93, 117, 130, 240, 308, 309, 315, 361, 367.

Specific Locality Data: 106, 109, 188, 202, 216, 252, 293, 296, 336.

Ecological Data: 216, 252.

Behavioral Data: 336.

Systematic Problems: 293.

Other: 361.

Storeria dekayi

General: 5, 19, 24, 46, 85, 117, 240, 308, 309, 315, 364, 367, 387.

Specific Locality Data: 256.

Storeria dekayi texana

General: 20, 91, 361, 386, 387.

Specific Locality Data: 109, 118, 188, 252, 293, 325, 336, 342.

Systematic Problems: 46, 91, 109, 118, 188, 252, 293, 325, 336.

Other: 293, 361.

Storeria dekayi wrightorum

General: 2, 20, 91, 287, 342, 361, 386, 387.

Specific Locality Data: 109, 118, 188, 252, 290, 293, 296, 325, 336, 342.

Systematic Problems: 46, 91, 109, 118, 188, 252, 293, 325, 336.

Other: 293, 361.

Storeria occipitomaculata

General: 5, 19, 24, 46, 85, 117, 240, 308, 309, 315, 364, 375, 387.

Storeria occipitomaculata occipitomaculata

General: 2, 20, 91, 215, 279, 287, 361, 367, 386, 387.

Specific Locality Data: 109, 118, 227, 279, 290, 293, 296, 336.

Ecological Data: 227.

Other: 293, 361.

Tantilla gracilis

General: 2, 19, 24, 33, 68, 79, 91, 100, 117, 144, 187, 206, 283, 287, 308, 309, 315, 361, 386.

Specific Locality Data: 58, 100, 109, 118, 126, 144, 188, 206, 229, 255, 256, 290, 293, 296, 324, 325, 327, 328.

Ecological Data: 58, 126, 144, 328.

Behavioral Data: 144.

Systematic Problems: 126, 206, 386, 387.

Other: 206, 327, 361, 387.

Terrapene

General: 364.

Terrapene carolina

General: 19, 24, 117, 130, 240, 266, 315.

Terrapene carolina carolina

General: 20, 73.

Specific Locality Data: 109, 336.

Systematic Problems: 336.

Terrapene carolina triunguis

General: 2, 19, 20, 22, 24, 73, 79, 91, 243, 263, 287, 308, 309, 326, 338, 361.

Specific Locality Data: 61, 96, 106, 109, 111, 188, 194, 199, 227, 231, 243, 249, 252, 267, 290, 293, 296, 310, 325, 327, 336, 362.

Ecological Data: 61, 194, 227, 231, 243, 252, 267, 327.

Behavioral Data: 267.

Systematic Problems: 243, 293, 310, 336.

Other: 96, 194, 199, 326, 361.

Terrapene ornata

General: 19, 24, 92, 130, 266, 268, 311, 315, 318.

Terrapene ornata ornata

General: 73, 91, 210, 231, 232, 243, 311, 318, 361, 367, 369.

Specific Locality Data: 106, 109, 188, 268, 293, 296, 369.

Ecological Data: 268, 293.

Other: 293, 361.

Thamnophis

General: 364.

Thamnophis proximus

General: 19, 24, 147, 148, 302, 319.

Specific Locality Data: 229.

Thamnophis proximus proximus

General: 17, 20, 91, 276, 277, 282, 302, 361, 386, 387.

Specific Locality Data: 58, 61, 109, 118, 188, 242, 275, 276, 277, 282, 293, 296, 325, 327, 336, 387.

Ecological Data: 58, 252, 293, 387.

Behavioral Data: 293.

Systematic Problems: 17, 293.

Other: 361, 387.

Thamnophis radix

General: 19, 24, 81, 117, 187, 232, 315, 319.

Thamnophis radix haydenii

General: 91, 308, 309, 361, 386.

Specific Locality Data: 109, 118, 293, 296.

Systematic Problems: 118.

Other: 361.

Thamnophis sirtalis

General: 5, 19, 24, 92, 117, 140, 178, 188, 240, 308, 309, 315, 318, 319, 375, 388.

Specific Locality Data: 229, 256, 282.

Systematic Problems: 229, 282.

Thamnophis sirtalis annectans

General: 20, 361.

Specific Locality Data: 118.

Systematic Problems: 118, 140, 282, 387.

Other: 361.

Thamnophis sirtalis parietalis

General: 5, 19, 20, 24, 46, 79, 242, 361, 386.

Specific Locality Data: 109, 118, 188, 226, 293, 296, 325, 327, 336.

Ecological Data: 242.

Behavioral Data: 242.

Systematic Problems: 46, 109, 118, 140, 188, 282, 327, 387.

Other: 242, 361.

Thamnophis sirtalis sirtalis

General: 5, 19, 20, 24, 85, 88, 91, 113, 215, 361, 367, 386, 387.

Specific Locality Data: 109, 118, 290, 293, 296, 360.

Systematic Problems: 109, 118, 140, 282, 367.

Other: 361.

Trionyx

General: 364.

Trionyx muticus

General: 19, 24, 46, 85, 117, 130, 240, 315, 319, 367, 372, 375.

Trionyx muticus muticus

General: 20, 73, 91, 308, 309, 361, 370, 372.

Specific Locality Data: 73, 109, 118, 188, 229, 252, 293, 296, 307, 321, 327, 336, 370, 372, 388.

Systematic Problems: 109, 118, 252.

Other: 307, 361, 370.

Trionyx spiniferus

General: 19, 20, 24, 85, 112, 117, 130, 240, 263, 308, 309, 315, 319, 367, 370, 373.

Specific Locality Data: 293, 307, 321, 336, 370, 373.

Ecological Data: 336.

Systematic Problems: 293, 294, 321, 322, 373.

Other: 307, 370.

Trionyx spiniferus asperus

General: 73, 294.

Specific Locality Data: 109, 118.

Systematic Problems: 73, 109, 118, 294, 321.

Trionyx spiniferus hartwegi

General: 51, 73, 79, 91, 287, 294, 318, 361, 370, 373, 374.

Specific Locality Data: 73, 106, 109, 118, 296, 321, 370, 373.

Behavioral Data: 106.

Systematic Problems: 73, 79, 91, 109, 118, 294, 321, 370, 373.

Other: 361.

Trionyx spiniferus pallidus

General: 79, 91, 124, 294, 361, 370, 373, 374.

Specific Locality Data: 109, 118, 296, 321, 370, 373.

Systematic Problems: 79, 91, 109, 118, 294, 321, 370, 373.

Other: 361.

Trionyx spiniferus spiniferus

General: 73, 91, 294, 361.

Specific Locality Data: 106, 109, 118, 252, 290, 296, 321.

Ecological Data: 252.

Behavioral Data: 106.

Systematic Problems: 73, 91, 109, 118, 252, 294, 321.

Other: 361.

Virginia striatula

General: 5, 19, 24, 68, 91, 100, 117, 187, 240, 287, 302, 308, 309, 361, 386, 387.

Specific Locality Data: 109, 118, 188, 229, 251, 252, 290, 293, 296, 325, 327.

Ecological Data: 252, 327.

Other: 293, 361, 387.

Virginia valeriae

General: 19, 24, 117, 240, 308, 309, 315.

Virginia valeriae elegans

General: 20, 42, 91, 97, 107, 187, 287, 302, 361, 386, 387.

Specific Locality Data: 109, 118, 227, 290, 293, 296, 324, 336, 387.

Ecological Data: 227.

Other: 293, 361, 387.

Extralimital and Problematical Records

Agkistrodon contortrix sub. sp.

100, 388.

Agkistrodon piscivorus sub. sp.

100.

Cemophora coccinea sub. sp.

100, 109, 388.

Clemmys insculpta

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Cnemidophorus gularis sub. sp.

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Cnemidophorus tessellatus

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Coluber constrictor sub. sp.

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Crotalus adamanteus

93, 100, 111, 165, 188, 214, 319, 321, 388.

Crotalus viridis sub. sp.

16, 100, 349, 388.

Crotaphytus collaris sub. sp.

15, 100, 169, 271, 388.

Diadophis punctatus sub. sp.

293.

Elaphe guttata sub. sp.

14, 15, 17, 51, 98, 100, 322.

Elaphe obsoleta sub. sp.

2, 75, 97, 214, 297, 301, 382, 383.

Eumeces anthracinus sub. sp.

100.

Eumeces brevilineatus

109.

Eumeces inexpectatus

19, 20, 79, 134, 211, 343.

Eumeces obsoletus

15.

Gerrhonotus sp.

364.

Gopherus polyphemus

68, 73, 109, 112, 165, 214, 229, 239, 263, 287, 322, 374.

Graptemys pseudogeographica sub. sp.

51.

Heloderma suspectum

109, 306.

Heterodon nasicus sub. sp.

15, 16, 100.

Holbrookia maculata

99.

Kinosternon flavescens sub. sp.

1, 19, 41, 101, 112, 192, 316.

Lampropeltis sp.

14, 15, 148.

Lampropeltis calligaster sub. sp.

100.

Lampropeltis getulus sub. sp.

15, 16, 100, 386, 388.

Lampropeltis triangulum sub. sp.

14, 31, 97, 98, 100, 376, 388.

Leptotyphlops dulcis sub. sp.

109, 118, 207, 361, 387.

Masticophis flagellum sub. sp.

16, 100, 388.

Micrurus fulvius sub. sp.

75, 109, 113, 281.

Nerodia erythrogaster sub. sp.

14.

Nerodia sipedon sub. sp.

288, 387.

Opheodrys aestivus

100.

Opheodrys vernalis sub. sp.

109, 159, 188, 293, 386, 387, 388.

Ophisaurus attenuatus sub. sp.

388.

Ophisaurus ventralis

2, 9, 85, 100, 101, 109, 110, 169, 181, 188, 224, 229, 256, 293, 306,
308, 309.

Phrynosoma cornutum

100, 108, 176, 388.

Pituophis melanoleucus sub. sp.

16, 332, 388.

Pseudemys scripta sub. sp.

61, 66, 109, 112.

Sceloporus olivaceus

198, 388.

Sceloporus undulatus sub. sp.

15, 100, 188, 325, 330, 388.

Sistrurus catenatus sub. sp.

85, 318, 319.

Tantilla gracilis

79.

Thamnophis elegans sub. sp.

100.

Thamnophis eques sub. sp.

188.

Thamnophis marcianus sub. sp.

51, 97, 100.

Thamnophis proximus sub. sp.

100, 388.

Thamnophis sauritus sub. sp.

5, 178, 315, 318.

Thamnophis sirtalis sub. sp.

100, 188, 282, 388.

Trionyx spiniferus sub. sp.

51.

Tropidoclonion lineatum sub. sp.

109, 185, 288, 307, 308, 323.

Virginia valeriae

98, 100, 109, 388.

Fossil Record

Carphophis amoenus

119, 150.

Catapleura arkansaw (Extinct)

286.

Coluber constrictor

119, 150, 382.

Crotalus horridus

84, 119, 150, 209, 390.

Elaphe guttata

119, 150.

Elaphe vulpina

119, 166, 182, 183.

Farancia abacura

150.

Heterodon sp.

119.

Lampropeltis calligaster

36, 119, 150.

Lampropeltis getulus

119.

Lampropeltis triangulum

119, 150.

Masticophis flagellum

119, 150, 381.

Phrynosoma cornutum

183, 269, 371, 395.

Phyllemys barberi (Extinct)

286.

Pituophis melanoleucus

119, 150.

Podocnemis barberi (Extinct)

285.

Thamnophis sirtalis

119, 150.

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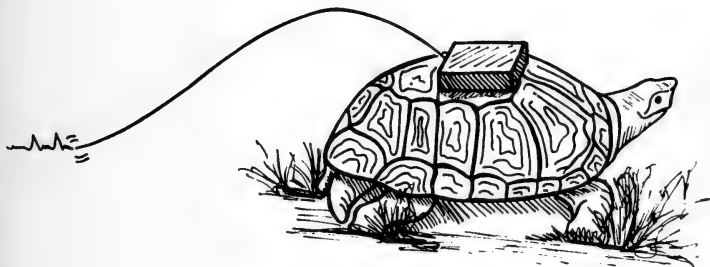
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A CONTROVERSY SURROUNDING AN ENDANGERED SPECIES LISTING:
THE CASE OF THE ILLINOIS MUD TURTLE
ANOTHER PERSPECTIVE



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INTRODUCTION

Recently, two articles were published (Dodd, 1982, 1983) summarizing the natural history, conservation activities, proposed federal listing and controversy surrounding the form considered by some (e.g., Iverson, 1979) as the Illinois mud turtle, Kinosternon flavescens spooneri, and by others (e.g., Houseal et al., 1982) as an isolated population of the yellow mud turtle, Kinosternon flavescens flavescens. Unfortunately, the proposed listing of this turtle as endangered has, in fact, generated considerable controversy. This controversy has resulted in greatly polarized positions and bitter, adversarial relationships between those having the opinion that the listing is critical to the continued existence of the turtle versus those having the opinion that the turtle is presently adequately protected, or at least as well-protected, without the listing as it would be with an endangered status afforded by the federal government.

Dodd (1982, 1983) provided a wide-ranging overview and expressed a number of personal opinions concerning the events surrounding the proposed listing of the Illinois mud turtle from his perspective. Representatives of Monsanto Agricultural Products Company (Monsanto) have presented their views and opinions concerning the matter in several forums, many of which were listed by Dodd (1982). The purpose of this paper is to present our views from the perspective of the persons who performed the 1979-1980 research which was supported by Monsanto. It also represents an attempt to partition aspects of the controversy into the realms which represent differences in opinions and interpretations of the data versus the adequacy and credibility of the data which were gathered (and the analyses which were performed) as part of Monsanto's research program.

In essence, this paper is intended to supplement Dodd (1982, 1983), providing additional case history. Dodd (1982) ended with the opinion:

"In the Illinois mud turtle controversy, no one benefitted, least of all K. f. spooneri."

While we do not agree with Dodd's statement, we believe that a careful review of this case history in its entirety will greatly benefit all in the scientific community who sometimes find themselves in the public arena with regards to their position on ecological issues.

NATURAL HISTORY

Dodd (1982, 1983) provided a brief summary of the natural history and ecology of the Illinois mud turtle referencing Cooper (1975), Springer and Galloway (1980) and Kangas et al. (1980) as containing detailed accounts. In general, the overview reasonably depicts the natural history of the turtle.

Material in Springer and Galloway (1980) concerning the present range, distribution, abundance and natural history of the turtle is now published (Bickham et al., 1984; Christiansen and Galloway, 1984; Christiansen et al., 1984, in press). Yet another manuscript describing the population estimation procedure developed from this project also has been prepared (Gazey and Staley, in press).

NON-FEDERAL CONSERVATION ACTIVITIES

Conservation activities directed towards preservation of the mud turtle and its habitat in Iowa, Illinois and Missouri by industry and state agencies have been extensive (Dodd, 1982). Each of the three states protects the turtle as endangered; Iowa since 1977, Illinois since 1978 and Missouri since 1979. The largest known population is located at Big Sand Mound, Iowa, where private industry has assumed responsibility for preservation of the habitat and the turtle as described below. Nevertheless, the status of the turtle is independently monitored by the Iowa Conservation Commission which has published an article including information on the mud turtle (Roosa, 1978).

Illinois, as described by Dodd (1982), has been active with regards to conservation of the turtle. Activities funded by the State have included surveys to evaluate its distribution and status (Morris, 1978) and ecological studies of the turtle at Sand Ridge State Forest for the purpose of developing a management program (Becker, 1980). The Illinois Department of Conservation published an information article about the turtle (Morris and Smith, 1981). As for Iowa, Roosa (1978) of the Iowa Conservation Commission published an information paper on the mud turtle.

The Missouri Department of Conservation has also expressed tangible evidence of their desire to protect mud turtle populations. The State has encouraged and supported ecological studies, provided technical assistance to individual land owners and is pursuing the opportunity to purchase privately-owned lands containing the second largest known population of the turtle (Dodd, 1982).

The Big Sand Mound site in Iowa is ringed by industry, namely Iowa-Illinois Gas and Electric Company (IIGE) and Monsanto. Both industries have contributed in a major way towards the conservation of the habitat and its residents, including the mud turtle. First, IIGE in the mid-1970's established the Big Sand Mound Nature Reserve on 420 acres of their property which was supplemented by 115 acres of Monsanto's property in 1981. As an advisory group for the management of the Big Sand Mound ecosystem, the Louisa Ecological Advisory Committee was established in 1977 by IIGE. This advisory group, consisting of representatives from private sector, state and federal government, is in part charged with the development of a master plan for management and protection of the Big Sand Mound Nature Reserve over the long-term (50 years). Monsanto is also providing assistance in the development of this plan.

The development of the master plan will be based largely upon a five-year study (1978-1982) conducted by Drake University with funding from IIGE and the 1979 study conducted by LGL Ecological Research Associates, Inc. with funding from Monsanto. Preliminary management procedures and experiments have already been implemented and include fencing of the site and controlling access, diking and filling drainage areas to control run-off of waters that might be of adverse quality, predator removal experiments, eradication of exotic plant species and, in 1979, pumping 80 million gallons of water into Spring Lake to raise the water level. Of these, all but the latter activity appeared to have greatly benefitted the

turtle and the system. Whereas, Dodd (1982) noted that filling of Spring Lake occurred only once, he failed to point out that this activity was discontinued because it was believed by the investigators (not Monsanto) to be ineffective as an enhancement tool. The turtles are adapted to use the ephemeral waters of spring and early summer, and are burrowed during the other times of the year. The successional pattern of aquatic macrophytes in shallow, permanent waters may not enhance the habitat for mud turtles (see Springer and Gallaway, 1980), and we recommended to Monsanto that pumping and filling be discontinued.

From the above, it is clear that the value of the disjunct populations of mud turtles is appreciated within the region in which they occur, and steps have been taken to insure their survival. Each state recognizes the populations to be endangered and, as such, the turtles are beneficiary of protective measures. Further, each state is actively pursuing research and enlightened management and protection measures for the turtle and its habitat. The site of the largest known population is now a nature reserve, and industry has provided large amounts of funding for study of the turtle.

PROPOSED FEDERAL ENDANGERED STATUS

Dodd (1982) described The Endangered Species Act and various amendments and executive orders as they relate to the proposed listing of the mud turtle as endangered. An endangered species is one in danger of extinction throughout all or a significant part of its range. The basis for considering the mud turtle in danger of extinction centered around Brown and Moll's (1979) contention that, in 1977, the total population of this turtle had declined, since about the late 1960's, to not more than 650 individuals living at only one or two localities in Illinois, and one in Iowa. Historically, the turtle had been known from some 13 localities across the three-state area including Missouri where, by 1977, it had presumably been extirpated. The populations at the Illinois sites were considered to be on the verge of extinction because of the small number of individuals remaining there and detrimental land-use practices. The situation for the population at the Iowa site, Big Sand Mound, was described in the Status Report (Brown and Moll, 1979) as a "classic horror story of economic growth versus a nearly extinct organism."

In early 1977, Dodd was preparing lists of amphibians and reptiles which might be candidates for federal protection but for which little supporting data were on file. According to information in letters on file in the Office of Endangered Species (OES) of the United States Fish and Wildlife Service (USFWS), Dodd contacted Dr. Lauren E. Brown and requested him to prepare an application to the OES proposing that the Illinois mud turtle be declared endangered. Given this application, Dodd placed the Illinois mud turtle on a Notice of Review and Dr. Brown was requested to prepare a status report which strongly urged federal protection.

In July 1978, the turtle was proposed as an endangered species (Dodd, 1978). Two areas were proposed as critical habitat--one at Big Sand Mound

and the other at Sand Ridge State Forest. Affected and interested parties were given up to 5 October 1978 to comment on the proposal. Monsanto was clearly affected, as part of the proposed critical habitat included not only their property but also some of the actual plant facility. Further, upon review of the Brown and Moll (1979) status report, they questioned the objectivity of certain sections of the report, particularly in regard to unsupported allegations suggesting chemical contamination of Spring Lake and air pollution.

It was at this point that we (LGL) were asked by Monsanto to evaluate the proposal and supporting documentation, addressing three specific questions:

- 1) Is the systematic status of the Illinois mud turtle known with certainty?
- 2) Is the population status of the Illinois mud turtle adequately defined by available information?
- 3) Assuming an endangered state, do plant site properties and adjacent properties represent critical habitat for Illinois mud turtles?

Following review of all available published and unpublished information as well as consultation with area experts and a series of site visits, a preliminary report addressing these questions was presented in September 1978, a report which also provided pre-study recommendations (Springer et al., 1978). It was determined that the systematic status of the Illinois mud turtle was not resolved and that the current population status and distribution were even less well known. Based upon existing conditions, LGL proposed a reduction in the proposed critical habitat at Big Sand Mound. With respect to Monsanto property, it was suggested that critical habitat should include all of Spring Lake and Monsanto Bay but not a connecting channel and mud flat north of Monsanto Bay which had been included as critical habitat by OES. The mud flat area collected runoff from the plant and was adjacent to a railroad tankcar storage area, such that it could have been subject to accidental spills of chemicals. We advised that the mud flat was not suitable turtle habitat and should be diked and filled to preclude use by turtles.

Other immediate management recommendations included: (1) that Monsanto develop a means for diverting water from the Mississippi River into Spring Lake in order to maintain water levels in the pond (if desired) without detrimentally affecting the underground aquifer, (2) that the apparent areas of turtle habitat on Monsanto property be fenced and posted as a wildlife preserve and (3) that predators be removed during the winter of 1978-1979. We reviewed these recommendations with interested state and federal representatives who indicated that they thought the recommendations were appropriate. All recommendations were followed.

In order to resolve questions (1) and (2) above, research efforts were proposed in the report and later funded by Monsanto. The objectives of the research were to:

- 1) Determine the taxonomic status of the Illinois mud turtle;
- 2) Delineate areas of potential habitat within Iowa, Illinois and Missouri based upon the presence of suitable sandy soil;
- 3) Further define the current distribution of the turtle based upon systematic searches;
- 4) Determine the population levels of Illinois mud turtles at Big Sand Mound and any other localities at which the turtles appeared well represented;
- 5) Through ecological studies at Big Sand Mound, delineate key processes necessary for the continued existence and well being of the turtle; and
- 6) Based upon the above, recommend a management plan for Big Sand Mound and define additional research needs.

Objective 1) grew out of the statement in the Brown and Moll (1979) status report, that the Illinois mud turtle might represent a distinct species. When we reviewed the available taxonomic data, we did not believe that it had been clearly established that the form was sufficiently differentiated even to be called a subspecies (sample sizes were small and results of quantitative analyses were not definitive). Whereas we were knowledgeable that even a population could be designated as an endangered species, we believed that from a resource evaluation standpoint, the question of the genetic uniqueness of the resource should be addressed.

Objectives 2) and 3) were directed towards determining the accuracy of the statements in the Brown and Moll (1979) status report that the number of localities at which the turtle was extant presently numbered not more than two or three sites. Brown and Moll (1979) had noted that since its discovery the turtle had never been considered common except at a few localities. The turtle was considered in the status report to have disappeared from most sites. based mainly on subjective opinion and results of only a few superficial surveys. Whether the turtle had indeed disappeared from a significant part of its range was considered crucial to the endangered species classification process.

Objective 4) is self-explanatory, mainly addressing the question whether population levels had declined at sites where the turtle had once been considered common. The Big Sand Mound site offered the opportunity to compare abundance in 1979 to that which had been measured in 1974 (Cooper. 1975). The latter data were not mentioned in the Brown and Moll

(1979) status report. Cooper (1975) had estimated as many as 3500 turtles might have been present in 1974, Brown and Moll (1979) suggested not more than 300-600 were likely present at Big Sand Mound based on a canoe trip made in 1976.

Objectives 5) and 6) were directed towards gathering information that could be used to protect and manage the turtle population at Big Sand Mound, regardless of its future legal status. Monsanto was advised that, regardless of the outcome of the proposed listing, the ecological resource represented at the Big Sand Mound site was of considerable value, and that they should take a major responsibility for its protection. They have done exactly that.

The aforementioned management activities designed to protect the turtles at Big Sand Mound were proposed to Dr. Dodd at a September 1978 meeting in Washington. In summary, it was suggested to Dr. Dodd that the basis for the listing appeared speculative and that Monsanto had volunteered to fund a study enabling an up-to-date evaluation of

- (1) the taxonomic status;
- (2) the present range and distribution;
- (3) present population levels; and
- (4) ecological requirements of the turtle.

This proposal of a comprehensive, structured survey, was not well received. The message was, in effect, that the data in hand (the status report and "other" data) adequately supported the listing, and there was no need to conduct additional studies until after the listing, presumably then under the auspices of OES. It was shocking to us to come away from a meeting, in which we fully expected encouragement and support, with the clear understanding that the staff herpetologist of OES had taken the position that no data generated by industry would have a bearing on the proposed listing. After all, how often does a major corporation take an interest in funding basic biological research on a cryptic endangered species? Dr. Dodd was, however, amenable to receiving progress reports on our range and distribution studies and the Big Sand Mound population and ecology study as they became available.

Representatives of state, federal, industry, and academic organizations involved in the issue were invited to attend a February 1979 Illinois mud turtle research workshop at Monsanto. At the workshop discussions were held regarding Monsanto's and IIGE's positions on mud turtle research. LGL's proposed research, taxonomy, the state's positions and recommendations, potential distribution in the three states, potential mud turtle habitat mapping, and standardization of data collection. The workshop was attended by representatives of the three state conservation agencies, Monsanto, IIGE, LGL, Drake University, Eastern Illinois University, Northeast Missouri State University, and Texas A&M University.

In addition, Jim Engel of OES attended and discussed OES's position and recommendations. Dr. Dodd was invited but did not attend.

The studies commenced in winter 1978-1979 with a predator-removal experiment (Christiansen and Gallaway, 1984). The surveys and population and taxonomic field studies were conducted during the spring and summer of 1979. Analysis and reporting of data commenced in fall with some aspects being completed in November 1979, and the balance being completed in January 1980 in time for the public meetings on the proposal. OES was kept advised as to the findings of the study by progress reports submitted every two weeks throughout the field studies. Further, results of all program findings to date were presented to the Louisa Ecological Advisory Committee (including a USFWS representative) at a 7 January 1980 meeting by presentation of a draft report which included certain conclusions but not all the supporting data (qualified in this regard at the meeting).

Historically, the Illinois mud turtle had been documented to occur at 13 localities. Our surveys documented 13 localities at which mud turtles were still present (not necessarily the same sites)--three sites in Iowa, eight in Illinois and two in Missouri (Bickham et al., 1984). One of the latter sites contains the second largest population known, probably over 400 turtles based on continuing studies. The Big Sand Mound site definitely contains over 1000 mud turtles, probably twice to three times that number. None of these findings, known to OES since summer of 1978, appeared to influence the proposal in any way even though they certainly provided no evidence of a marked decline in range (Bickham et al., 1984) or in the population at Big Sand Mound, as had been claimed in the status report.

Results of our taxonomic studies indicated that the disjunct populations of mud turtles in Iowa, Illinois and Missouri had not become genetically distinct to the point of representing a subspecies (Houseal et al., 1982). This has been confirmed by Berry and Berry (1984).

Based upon all of the above findings (all well-documented by hard data) and the commitment of the respective States and private industries to protect mud turtle populations and their habitats, we proposed that there was no need for federal protection. Although the form was considered by us to be threatened, particularly in Illinois, we did not believe its status was as precarious as presented in the Brown and Moll (1979) status report and, significantly, that it was being well-tended in the region by local and state activities.

CONTROVERSY AND MISUNDERSTANDING

Dodd (1982) stated that few proposed listings generated such opposition as the proposal to list the Illinois mud turtle as endangered, and that the opposition stemmed from Monsanto. Monsanto challenged the listing because much of the rationale in the Brown and Moll (1979) status report appeared based upon opinion and were not supported by data. They funded studies to test the key hypotheses implied by the status report,

namely the disappearance of the turtle from most of its range, the decline in numbers and the genetic uniqueness of the form. They were prepared to accept the listing if the status of the turtle was indeed as precarious as defined and, if so, to underwrite a model program for protecting an endangered population occurring in proximity to one of their plant sites. This desire was, in fact, the basis for the extensive ecology studies at Big Sand Mound.

Dodd (1982) stated that there was no indication to the USFWS of serious problems concerning the listing until 27 July 1979 when Monsanto presented testimony at the Endangered Species Act oversight hearings for the subcommittee chaired by Congressman John Breaux. He notes the previous September 1978 meeting with Monsanto where the management and research plans were presented mentioning that two points were made clear by him at that meeting: (1) that there were more data used in the proposal than sole reliance on the Brown and Moll (1978) report and (2) that taxonomy was not an issue. At this point, Monsanto was not necessarily opposed to the listing, depending upon the outcome of the surveys and population level studies. They maintained, however, that the referenced data were not apparent and genetic uniqueness should have a bearing on the proposal since the uniqueness issue had been raised in the status report. Monsanto believed that the existing data were not adequate to make a determination of status and that additional data should be gathered before a determination was made.

At the time of the July 1979 oversight meetings, most of the survey data were in hand, and had been transmitted to OES. These data showed conclusively that the mud turtle was still represented over much of its historical range and included the discovery of a potentially large population in Missouri where it was formerly believed to be extinct. It was likewise known that the population level at Big Sand Mound was much larger than had been represented in the Status Report. OES had been supplied this information by the progress reports submitted every two weeks during the study, as the data were being compiled, yet had not in any way acknowledged their existence or modified the proposal based upon the new information. Monsanto was indeed critical, believing that OES was continuing to operate on the basis that the mud turtle was nearly extinct, when there was good evidence to the contrary.

Dodd (1982) next cited a letter of 14 November 1979 from Monsanto to the Assistant Director for Congressional Relations as evidence that Monsanto had been anticipating results of the studies prior to their completion. There was no premature anticipation. At that time, the turtle was known to be more widespread and abundant than claimed in the Status Report. Only the taxonomic data were still in doubt. The conclusions concerning distribution and total numbers in the status report had, however, been conclusively refuted. As Monsanto made more people besides OES aware of this as early in the process as possible, OES received a great deal of questioning as to why these data were not being considered. From Monsanto's viewpoint, there appeared to be either a definite reluctance to accept the results of the distributional and population findings or the results were not going to make any difference in the listing process. Acknowledgement of and response to these data as

they became available would have gone far towards reducing the misunderstandings.

As described by Dodd (1982), he was notified by a regional USFWS representative that a draft final report was available on 7 January 1980 which described the results of the surveys and some preliminary taxonomic conclusions based upon results of analyses completed to date. The regional office was told that there was no need to forward this report since a final report was scheduled for submittal on 30 January 1980. A few days later (11 January 1980) he accepted a copy of this report (which was not marked draft) from staff members of the Senate Environment and Public Works Committee as a response from them to his question of what data were being ignored. Even though he had been advised only three or four days earlier that a draft report bearing a November 1979 date was just now (January) available, and that the final report was not due until some 19 to 20 days later, he somehow perceived this report as being the final report and sent it out for review (without any notification to us) by nine turtle specialists. A simple telephone call at this point could have greatly lessened the ultimate misunderstandings.

Dodd (1982) reported that "All respondents severely criticized the many conclusions with little or no supporting data." This response could have been anticipated, given that the report was a draft. Further, most of the criticism (not all) was directed at the taxonomy sections--the data were not included in the draft. However, not all the reviewers were entirely critical. For example, with regards to the distribution studies, one of the reviewers noted that "The report performs a valuable service by demonstrating, contrary to the conclusions of the Brown and Moll report, that additional, extant populations of K. f. spooneri do indeed exist. I agree with the authors of the LGL report that the Illinois Mud Turtle is not on the verge of extinction." Among the most critical of these reviews (dated 20 January 1980), was that provided on the taxonomy section by Dr. J.B. Iverson of Earlham College who had authored the most recent taxonomic work prior to this study.

Unaware of the OES review, we had earlier invited Dr. Iverson, along with others, to a meeting at Texas A&M University on 23 January to evaluate the taxonomic analyses which had been conducted prior to their presentation at the public meetings. Dr. Iverson reviewed the results and agreed that the data that had been collected and analyzed up to that time were valid and did not support the recognition of spooneri as a valid subspecies. However, he suggested several additional multivariate analyses were necessary before definite conclusions were drawn. He did not indicate that he had recently reviewed the draft report.

Results of our analyses and supporting data were presented at the public meetings on 30-31 January. At the first of these meetings, one of the nine reviewers of the January draft report, Dr. Lauren Brown, presented his review of the report, variously characterizing it as "biased", "improperly conducted" and not a "free inquiry". From our perspective, it was at this point that the listing process became an emotionally-charged controversy. The belief that objectivity was not

being maintained by the OES was reinforced by the content of certain OES file letters concerning the project.

In response to such allegations, we submitted our report (this time complete) to a different set of turtle experts, all well known in their field for their expertise and integrity. The results of these reviews were quite different from the previous ones, being generally favorable or at least objective. Results from these and the previous reviews were responded to with an addendum (Bickham and Gallaway, 1980) to the Final Report which had been presented at the public meetings. All data were submitted to OES by 6 March 1980. As noted by Dodd (1982), Monsanto also suggested in March 1980 that all the data on hand be evaluated by an independent review panel of qualified scientists prior to any decision about the listing, given the criticism of the data which had occurred. The comment period was closed in late March.

OES proceeded with the listing, approving the final rule by 29 April 1980. However before approving the rule, the Director of USFWS, acting upon Monsanto's suggestion, requested the assistance of the National Academy of Sciences in evaluating all the data which were on hand concerning the listing. Whereas the LGL data showed the turtle to be more secure and less unique than claimed in the status report, the validity of the LGL data had been challenged as described by Dodd (1982). The Academy responded by recommending a number of turtle biologists and statisticians that would be qualified to conduct such a review, not being able to organize a panel and respond themselves, given the restrictive time frame (Dodd, 1982). To Monsanto, the recommendation of a scientist as qualified to serve on such a review panel by the Academy equated to an endorsement. The six member panel was chaired by the Chief of USFWS's Wildlife Ecology Research Division, David Trauger. It included a program participant not from LGL, Dr. J.L. Christiansen, and a program critic, Dr. Iverson, in addition to four scientists who had not participated in the studies or their previous review.

The panel was given five questions to respond to, and a copy of the entire Panel Report is reproduced in Figure 1. As can be seen, the status report was given a less favorable review than the LGL report by this independent group. Whereas there remains room for differences in opinions as to how the data should be interpreted, there should be no basis for continued references to questions about the validity of (or even the existence of) adequate supporting data on which our interpretations and conclusions were based.

On 11 June 1980, a memorandum written by Trauger but signed by Richard N. Smith, Associate Director - Research, FWS, concluded (Dodd, 1982):

"Based on the report of the Review Panel, insufficient information is available on the Illinois Mud Turtle to justify listing it as a threatened or endangered species by the U.S. Fish and Wildlife Service at this time. There is a need to

conduct further research to clarify the complex taxonomic relationship and to estimate the total population of this subspecies. The Illinois Mud Turtle is considerably more abundant and widely distributed than previously thought. Local and private efforts should be encouraged to promote its conservation and to protect its habitat. The Panel favored this strategy as the one most likely to succeed."

Following this memorandum, the Director of the USFWS withdrew the final rule which had been held up pending a decision. The notice withdrawing the Illinois mud turtle from consideration as a candidate for endangered status was published in August 1980, over the objection of OES.

DISCUSSION AND CONCLUSIONS

Dodd (1982) suggested that Monsanto's opposition to the listing might have been automatic stemming from a belief that environmental regulations are a luxury in a society facing economic problems. We do not believe this to be the case. Monsanto was prepared not to oppose the listing had the results of the studies suggested federal protection was warranted. Based upon the results of the studies, however, in combination with the protection the turtle and its habitat were already receiving, they honestly did not believe that federal protection was necessary. They felt, with good cause, that the information that they had gathered was not being seriously considered or given fair treatment, particularly as compared to the Brown and Moll (1979) status report.

We fail to see the basis for Dodd's (1982) statement that "Almost the entire controversy focused on one particular area. Big Sand Mound, and indeed, only on 20% of Big Sand Mound." The major finding of the study that most affected the listing was that the turtle was much more widespread and abundant than formerly believed--it had not largely disappeared from its former range (Bickham et al., 1984). This finding was based upon surveys of selected sites within appropriate habitats over a three-state area, not just the results of ecology studies at Big Sand Mound.

These critical surveys were supported only by Monsanto, but this fact in no way slights IIGE and state activities involving protection of the turtle, as stated by Dodd (1982). The activities of IIGE and the states (and Monsanto) are, in fact, the keystone to the idea that, although threatened, the mud turtle is already well protected and is without dire need for assistance from the federal government.

Dodd (1982) next turned to the question of professional ethics in the controversy, noting that "Data misrepresentation, omission, or overstatement has no place in scientific circles", and that the peer review system is designed to insure "accuracy and competence of data and its interpretation." He went on to state that all publications used by USFWS had been submitted to peer review and published by reputable journals prior to the OES decision in 1980 to proceed with the listing.

He then noted that all reports opposing the listing, "admittedly with LGL's qualifications concerning data analysis" were severely criticized by the majority of the reviewers and only one paper had been submitted and accepted for publication. What was omitted here, is that the critical reviews in question appear to be those which related to the incomplete draft report of January 1980, and that the initial publication referenced (Houseal et al., 1982) presents the results of the taxonomic studies--the most criticized aspect of the program based upon the initial reviews of the incomplete draft report. The implication is that most of the LGL findings were of dubious quality and not of a publishable nature. At present, the key findings concerning the distribution and range of the turtle are published (Bickham et al., 1984), as are the results of the predator removal program (Christiansen and Galloway, 1984) and a note on reproduction in the species (Christiansen et al., 1984). Papers on natural history and behavior (Christiansen et al., in press) and population estimates are in press (Gazey and Staley, in press). The validity of the key results of the program have been, and are continuing to be established via their publication in reputable scientific journals. We also submit that the Panel Review in 1980 represented a rigorous peer review.

The responsibility of a scientist regarding subsequent use of published information was an issue raised by Dodd (1982). He stated "...extreme care must be used whenever one's name is on a report or paper to insure that the contents are not misused, as was done with Springer and Galloway (1979)." The responsibility of a scientist, when doing any research, is to produce the most accurate data possible and to interpret those data in an unbiased manner. The final report was a document that was purchased by the contractor, and the contractor has a right to decide how the document will be used. To suggest that an author is somehow responsible for the use to which his published work is put is ludicrous. Further, we dispute Dodd's (1982) implication that Monsanto "misused" the report. Dr. Dodd was an employee of a highly visible government agency (OES) and should have understood that lobbying is one way our political system works. Such activity should not surprise government employees or the public.

Dodd stated that Monsanto's implication of a National Academy of Science endorsement of the USFWS Review Panel is unethical. Given that the review panel was selected by the USFWS from a list of scientists judged to be qualified to evaluate the studies which was provided by the National Academy of Science, we do not agree with Dodd's assessment. This appears to be a case of hair-splitting.

Dodd (1982) claimed that the USFWS stalled the listing, focusing on the false issue of taxonomy. It should be noted that the taxonomy issue was a relatively minor one until results of the initial review solicited by Dodd focused on this aspect in such a critical way. For example, one of the reviewers claimed to have been "shocked" that we had dismissed the subspecies without any presented data and that it was becoming increasingly clear to him that we had set out in the beginning to sink the taxon in our own best interest. Dodd (1983) stated that the subspecific status of the Illinois mud turtle was undisputed until Houseal et al.

(1982) questioned its taxonomic validity. This is clearly untrue because Brown and Moll (1979) suggested the form may be a distinct species in the original status report, as we pointed out earlier in this paper. Thus, the issue of distinctness of the turtle was raised prior to the Monsanto studies.

Further, Dodd (1983) stated "There is considerable controversy over the suitability and interpretation of the statistical techniques used by Houseal et al. (1982) and it appears unlikely that the taxonomic question will be settled in the near future." He does not cite the source of the controversy but we first became aware of technical criticisms by John B. Iverson at the Public Meeting in Iowa. It is pointless to debate such issues here but the statistical methodologies employed by Houseal et al. (1982) have been used numerous times in the literature and, indeed, the UPGMA cluster analysis is a standard method used in most multivariate analyses of geographic variation. OES funded an independent study (Berry and Berry, 1984) that repeated our study and found almost precisely what Houseal et al. (1982) found--the taxon *K. f. spooneri* was invalid.

The real issue stemming from this example concerns the question of how much must be known before proposing a species as endangered and whether affected parties have the right to conduct studies challenging endangered classifications when these appear to be based upon scanty data. Such studies should be welcomed by agencies charged with making a determination. Further, if studies are conducted, who should evaluate conflicting findings--those making the proposal or a qualified third party? Additionally, at what point is federal protection required if local and state protection is being provided, and who should make this decision? In some cases, the decision regarding the need for federal protection is clear (e.g., California condor); but others are not (e.g., Illinois mud turtle). Although painfully derived, perhaps the procedure of an independent third party review in controversial cases represents a good approach.

Dodd (1982) stated that the proposal was withdrawn because of intense political controversy. We disagree, believing that the USFWS withdrew the listing because of their stated reasons which were biological in nature and took into consideration the protection the turtle was being provided at the state and local level. The "political" aspects of the controversy were only directed towards gaining the opportunity to be heard and to be fairly evaluated. All other doors to the OES were closed.

The mud turtle is actively protected by state and local organizations and all that can be done within reason is being done or contemplated. It is not presently in need of federal protection. Should the existing state and local commitments to its protection change, it once again, and rightfully, can be considered for federal protection. In the Illinois mud turtle controversy, no human may have benefitted but the turtle certainly did. It gained a national versus regional exposure, and its status will be closely monitored.

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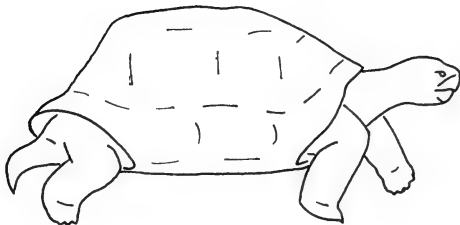
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INTRODUCTION

There are many species of animals whose present day existence is dependent upon man's attempts to insure their survival. One such example is the giant tortoise endemic to the Galapagos Islands. These tortoises are now extinct on all but six of the larger islands, and even these populations are threatened with extinction.

Due to the early work of Darwin (1875) and the uniqueness of the Galapagos fauna, international attention has been focused on these islands for further exploration and study. Through the combined conservation and management efforts of the Charles Darwin Research Station (CDRS) and the Galapagos National Park Service, research and study of this environment is being continued. As a result, the surviving populations of giant tortoise have stabilized, and some are returning to their former abundance.

Papers resulting from these studies provide interesting information for the novice and pertinent data for the scientist regarding the life histories of Galapagos fauna. The giant tortoise is an endangered animal and all information concerning it is of significance. This bibliography is intended to serve as a reference tool for those interested in the giant tortoise. It contains articles covering many aspects of tortoise natural history.

In obtaining material for the bibliography, I attempted to include all technical and popular articles where new data or insights were given. The bibliography is complete through 1984. I hope this bibliography will be useful in providing essential information for those interested in the Galapagos giant tortoise.

I wish to acknowledge and thank the following individuals and institutions for their help in compiling this bibliography. The Charles Darwin Research Station and the Galapagos National Park Service, gave me the opportunity to study the giant tortoise in the islands. Loma Linda University provided research funds. Tina Blankenship, Virginia Hansen, Floyd Hayes, and Ernie Schwab reviewed the manuscript and gave helpful suggestions where needed. A special thanks to "Prof" Lester E. Harris, Jr. who stimulated my interest in Herpetology and who has been a real inspiration.

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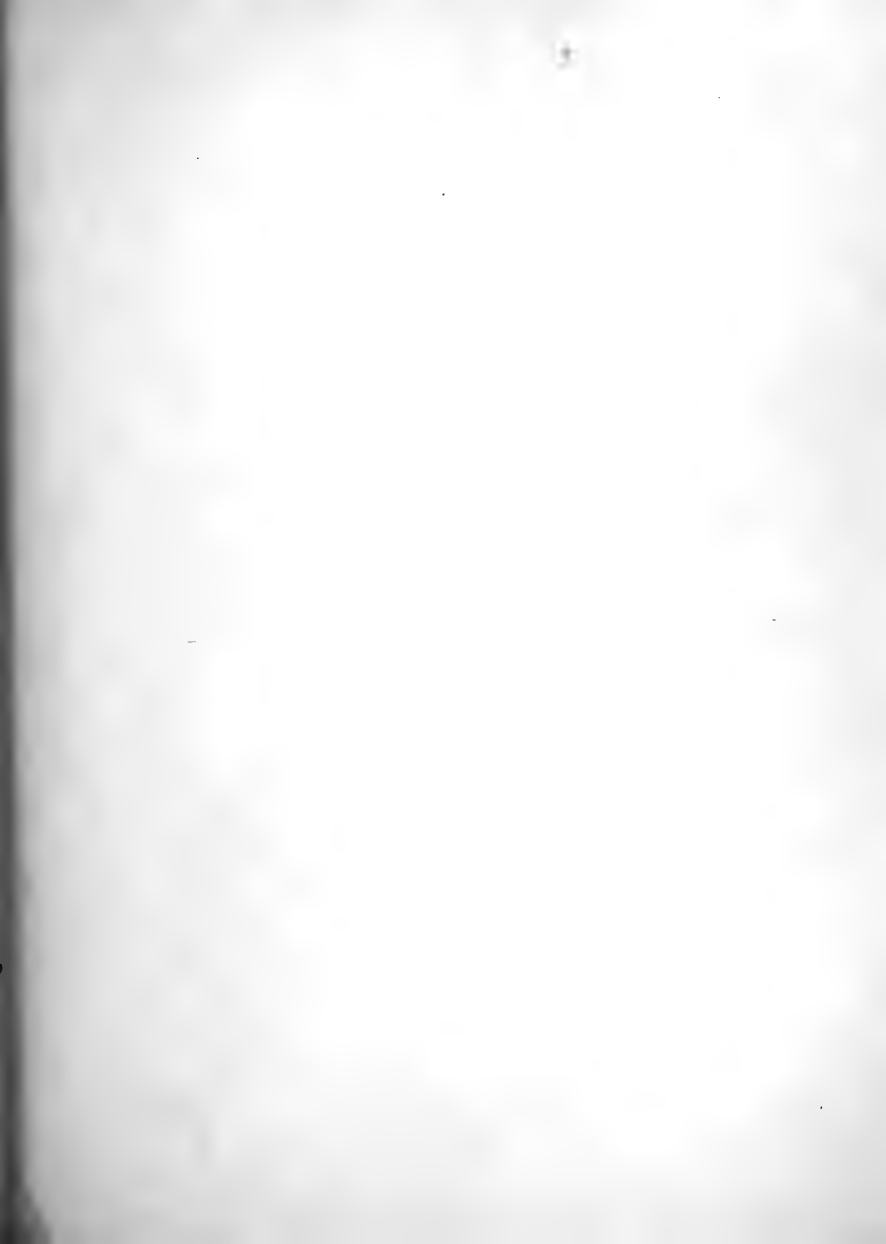
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This bibliography includes all references known to the author to contain explicit mention of any New Caledonian amphibian or reptile. In the case of endemic taxa this includes any and all references. For taxa shared with other geographical regions only references citing New Caledonian specimens are included. References on both terrestrial and marine species are included. Bibliographies, species lists and type catalogues which reference specimens or papers relative to New Caledonian herpetology are also included in this list.

The geographical region covered by the bibliography is the French Overseas Territory of New Caledonia and its dependencies exclusive of the Wallis and Futuna Islands in western Polynesia. This includes the main island of New Caledonia and its nearshore islands, the Isle of Pines, the Belep Islands, Surprise Island, the Huon Islands, the Loyalty Islands, Walpole Island, the Chesterfield Islands and Matthew and Hunter Islands.

The bibliography is annotated by a series of three numbers or sets of numbers corresponding to category designations for (1) taxa discussed, (2) subject material and (3) relative significance in terms of the New Caledonian herpetofauna. Taxonomic divisions are made at the family level or higher. Subject material headings include eleven broadly interpreted categories. Papers may have one or more ratings in this category (or when inapplicable, as in the case of species lists or bibliographies, may be represented by a [-]). The third category, relative significance, is a subjective ranking of the references included. References are assigned a ranking based solely upon their value to the student of New Caledonian herpetology. This ranking does not take into account any other criteria. Thus some relatively obscure references dealing directly with some aspect of New Caledonian reptiles may have a much higher rank than major works which presents relatively little data explicitly relating to New Caledonian taxa. Papers are indexed by taxonomic category in a list following the alphabetized citations.

It is hoped that this bibliography will serve as a guide to herpetologists working in the western Pacific Basin as well as to those concerned with taxa which include New Caledonian representatives. While every attempt has been made to include all pertinent references, omissions are bound to occur. Additional references sent to the author would be appreciated and will be incorporated into future revisions of this bibliography.

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KEY TO CODED ANNOTATIONS

Taxa	Subject Matter	Significance
1.Amphibia	1.Systematics	1.Major references on broad topics of direct applicability to N. C. herpetology.
2.Reptilia (general)	2.Morphology	
3.Meiolaniidae	3.Ecology	2.Major references on restricted topics, major reviews.
4.Cheloniidae	4.Behavior	
5.Crocodylia	5.Reproduction	3.Minor primary references (includes most species descriptions, minor reviews.
6.Gekkonidae	6.Ontogeny	4.Minor secondary reference, no information not contained by works in 1, 2 and 3.
7.Scincidae	7.Paleontology	
8.Varanidae	8.Parasitology	5.Bibliographies, type catalogues, species lists, etc.
9.Typhlopidae	9.Human contact	
10.Boidae	10.Distribution	6. Photograph only.
11.Hydrophiidae	11.Toxicology	

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TAXONOMIC INDEX

1. Amphibia: Ash (1968); Barbour (1912); Bell (1982); Böhme and Henkel (1985); Carlquist (1965); Conic (1958); Copland (1957); Darlington (1957); Darlington (1969); Duellman (1977); Hedley (1899); Holloway (1979); Jacobs (1976); Loveridge (1945); Moore (1961); Morat et al. (1984); Neill (1964); Parker (1938); Robinson (1972); Roux (1913); Sarasin (1917); Sarasin (1925); Sauvage (1878); Solem (1958); Solem (1959); Sternfeld (1920); Thorne (1963); Thorne (1965); Thorne (1969); Tyler (1972); Tyler (1976); Tyler (1979); Tyler (1982); Tyler and Davies (1978).
2. Reptilia (General): Anonymous (1984); Bauer (1985b); Bavay (1869); Böhme and Henkel (1985); Carlquist (1965); Caughley (1964); Conic (1958); Darlington (1957); Darlington (1969); Gaskin (1970); Holloway (1979); Jacobs, 1976; Loveridge (1945); Lucas and Frost (1897); Mayr (1945); Medway and Marshall (1975); Morat et al. (1984); Peters (1870); Robinson (1972); Romer (1956); Roux (1913); Sarasin (1917); Sarasin (1925); Sauvage (1878); Schmidt (1930); Solem (1958); Solem (1959); Sternfeld (1920); Stevens (1977); Stevens (1980); Thorne (1963); Thorne (1965); Thorne (1969); Trouessart (1890); Trouessart (1988); Virot (1956); Ward (1984); Werner (1901).
3. Meiolaeniidae: Anderson (1925); Cassels (1984); Darlington (1948); Darlington (1957); Fletcher (1960); Gaffney (1981a); Gaffney (1981b); Gaffney (1983); Gaffney et al. (1984); Mittermeier (1972); Mittermeier (1984); Paramanov (1958); Pritchard (1979); Raven and Axelrod (1972); Romer et al. (1962); Sutherland and Ritchie (1977); Swinton (1958).
4. Chelonidae: Anonymous (1980); Anonymous (1984); Bavay (1869); Bustard (1976); Chimmo (1856); Godard (1982); Jouan (1863); Jouan (1864); Laboute and Magnier (1979); Mack et al. (1980); Navid (1980); Pisier (1983); Pritchard (1979); Pritchard (1981); Rancurel (1974); Rancurel (1980); Roux (1913); Shadbolt and Ruhen (1971); Vidal (1978).
5. Crocodylia: Buffetaut (1983).
6. Gekkonidae: Andersson (1908); Anonymous (1985); Arnold (1984); Association pour la Sauvegarde de la Nature Néo-Calédonienne (1982); Baird (1970); Baker (1928); Bartmann and Minuth (1979); Bauer (1985a); Bauer (1985b); Baumann-Bodenheim (1954); Baur (1897); Bavay (1869); Bellairs (1969); Bocage (1873a); Bocage (1881); Boettger (1893); Böhme and Henkel (1985); Boring et al. (1949); Boulenger (1878); Boulenger (1879); Boulenger (1883); Boulenger (1887); Boulenger (1902); Brongersma (1932); Brongersma (1934); Brown (1956); Brown (1977); Bull and Whitaker (1975); Burt and Burt (1932); Carlquist (1965); Carlquist (1974); Cogger (1971); Cogger and Heatwole (1981); Cracraft (1980); Cuvier (1829); Darlington (1957); Diamond (1984); Ditmars (1933); Duméril (1856); Duméril and Bibron (1834-1854); Etheridge (1967); Fitch (1970); Fitzinger (1843); Godard (1983); Gray (1845); Gruber (1975); Guibé (1954); Guichenot (1856); Gundy and Wurst (1976); Günther (1872); Hardy and Whitaker (1979); Henkel (1981); Henle (1981); Hoffmann (1890); Hoffstetter and Gasc (1969); Hollyman (1982); Jarvis (1965); Jouan (1863); Kluge (1967a); Kluge (1967b); Kluge (1982); Kramer (1979); MacArthur and Wilson (1967); Maderon and Chiu (1970); McCann (1953); McCoy (1980); McGregor (1977); Medway and Marshall (1975); Meier (1979); Mertens (1934a); Mertens (1964a); Mertens (1964b); Miller (1984); Miller (1966); Müller (1974); Palacký (1899); Rieppel (1976); Rieppel (1984a); Rieppel (1984b); Robb (1980); de Rooij (1915); Roux (1913); Russell (1972); Russell (1979); Sauvage (1878); Schaefer (1902); Schmid (1981); Schmid (1985); Smith (1935); Smith (1937a); Stejneger (1899); Terent'ev (1961); Thomas (1981); Thomas (1982); Towns (1974); Underwood (1954); Underwood (1955); Underwood (1970); Underwood (1977); Wallace (1876); Wermuth (1965); Werner (1899); Werner (1900); Werner (1908); Werner (1909); Werner (1930); Werner (1969); Whitaker (1976); Woodland (1920).

7. Scincidae: Andersson (1908); Angel (1935); Baker (1928); Baur (1897); Bavay (1869); Bocage (1873b); Bocage (1881); Böhme (1976); Böhme (1979); Böhme and Henkel (1985); Boulenger (1887); Brocchi (1876); Brongersma (1945); Brown (1956); Bull and Whitaker (1975); Burt and Burt (1932); Carlquist (1965); Carlquist (1974); Cracraft (1980); Darlington (1957); Diamond (1984); Fitch (1970); Greer (1970); Greer (1973); Greer (1974); Greer (1976); Greer (1979); Greer (1980); Greer and Parker (1968); Guibé (1954); Hannecart and Letocart (1980); Hardy (1977); Jouan (1863); Kramer (1979); Loveridge (1941); McCoy (1980); McGregor (1977); Medway and Marshall (1975); Meier (1979); Mertens (1928); Mertens (1931); Mertens (1934a); Mertens (1964c); Mertens (1967); Mittleman (1952); Palacký (1899); Parker (1926); Peters (1870); Peters (1879); Robb (1980); de Rooij (1915); Roux (1913); Smith (1937b); Stejneger (1899); Towns (1974); Wallace (1876); Werner (1900); Werner (1909); Whitaker (1976); Zug (1985).

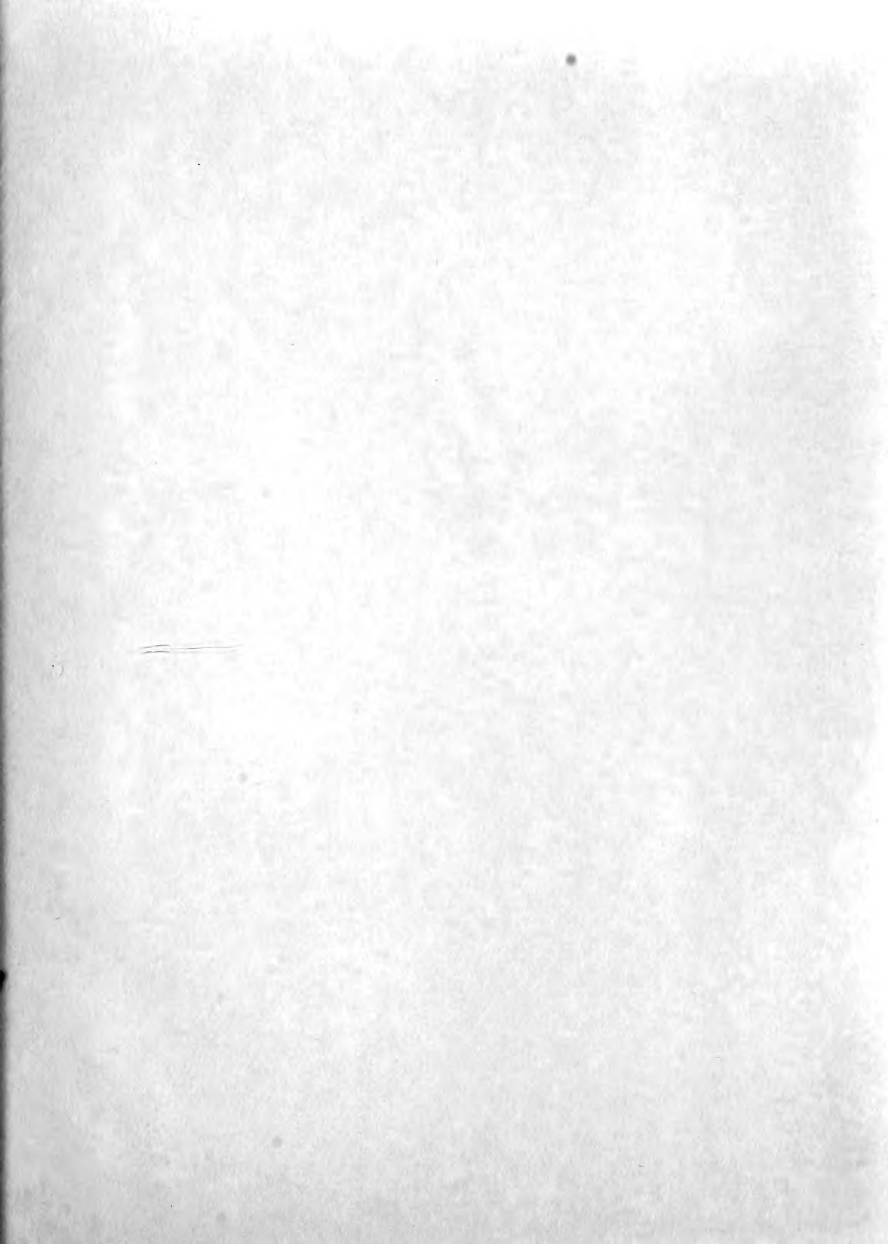
8. Varanidae: Gaffney et al. (1984).

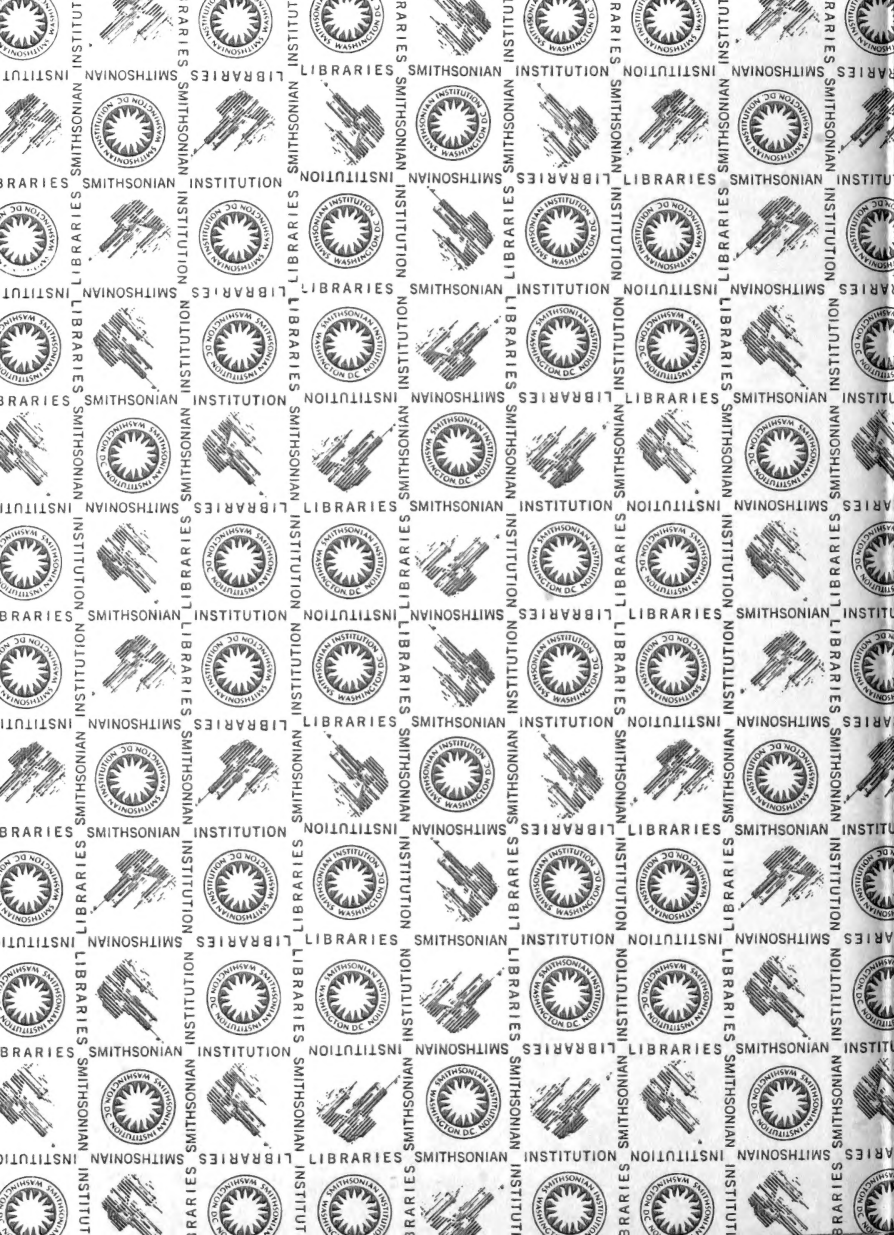
9. Typhlopidae: Boulenger (1902); Hahn (1980); McDowell (1974); Palacký (1898); Peters (1878); Roux (1913); Waite (1918).

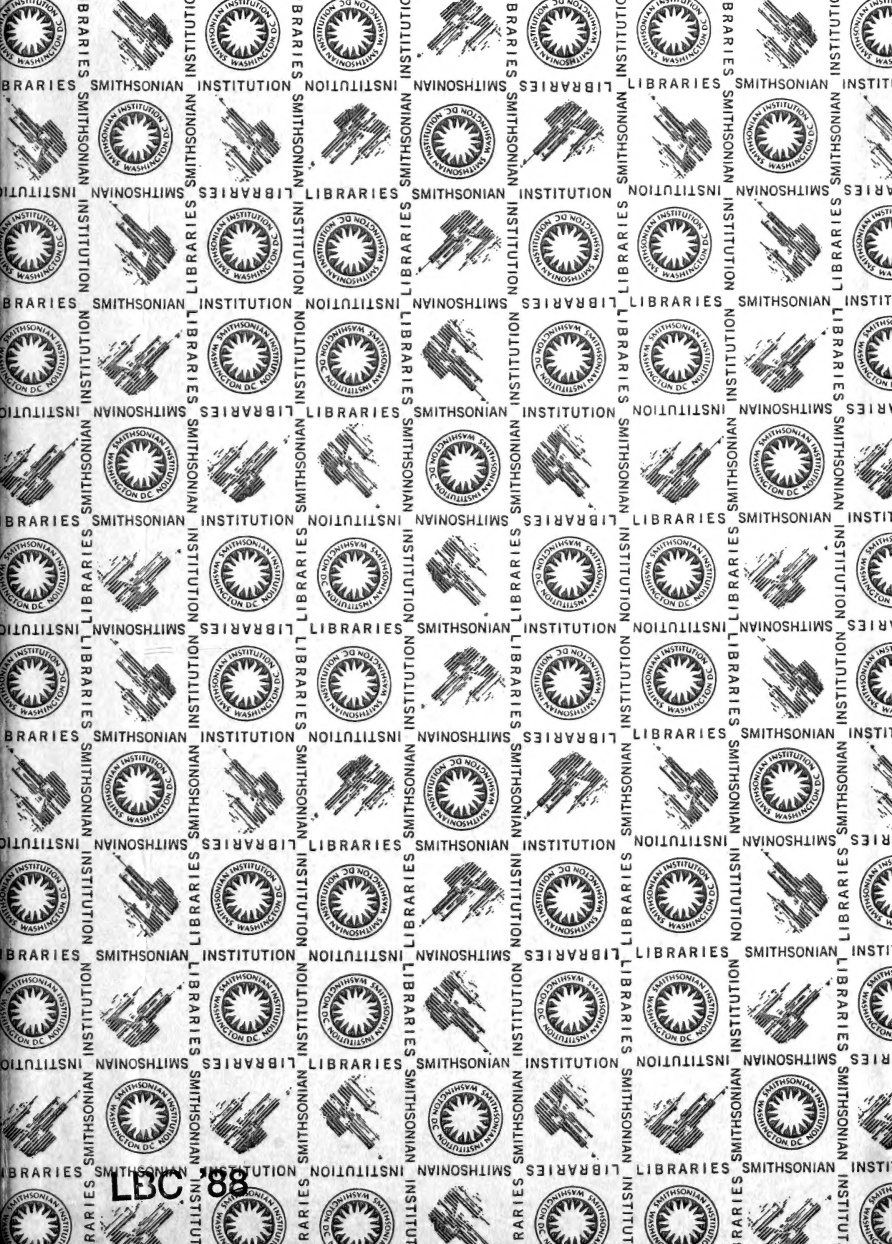
10. Boidae: Boulenger (1896); Burt and Burt (1932); Fourcart (1951); Jouan (1864); McDowell (1979); Mertens (1934a); Montrousier (1860); Palacký (1898); Petzold (1963); de Rooij (1917); Roux (1913); Stimson (1969); Stull (1935); Trouessart (1890).

11. Hydrophiidae: Barbour (1912); Barme (1968); Bavay (1869); Böhme and Henkel (1985); Boulenger (1892); Boulenger (1896); Boulenger (1898); Bourret (1979); Caras (1974); Cloitre (1965); Cogger (1975); Cogger (1983); Duméril and Bibron (1834-1854); Dunson (1975); Forné (1888); Gail and Rageau (1956); Gail and Rageau (1958); Godard (1982); Godard (1983); Habermehl (1981); Halstead (1970); Hardy and Welch (1980); Hecht et al. (1974); Jouan (1863); Jouan (1864); Kellaway and Kinghorn (1943); Kinghorn (1956); Klemmer (1963); Klemmer (1975); Laboute and Magnier (1979); Ledroit (1983); McDowell (1972); Mertens (1934b); Mialaret (1897); Minton (1975); Pernetta (1977); Pisier (1983); Rageau (1960); Rageau and Vervent (1959); de Rooij (1917); Roux (1913); Saint Girons (1964); Saint Girons (1975); Saint Girons et al. (1964); Sauvage (1877); Smith (1926); Southcott (1957); Sutherland (1983); Vigle and Heatwole (1978); Voris (1977); Wall (1909); Werler and Keegan (1963); Wilson (1970).









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